SANDIA REPORT

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Site Environmental Report for 1999, Sandia National Laboratories, California

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Prepared for
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Kirtland Area Office

Prepared by
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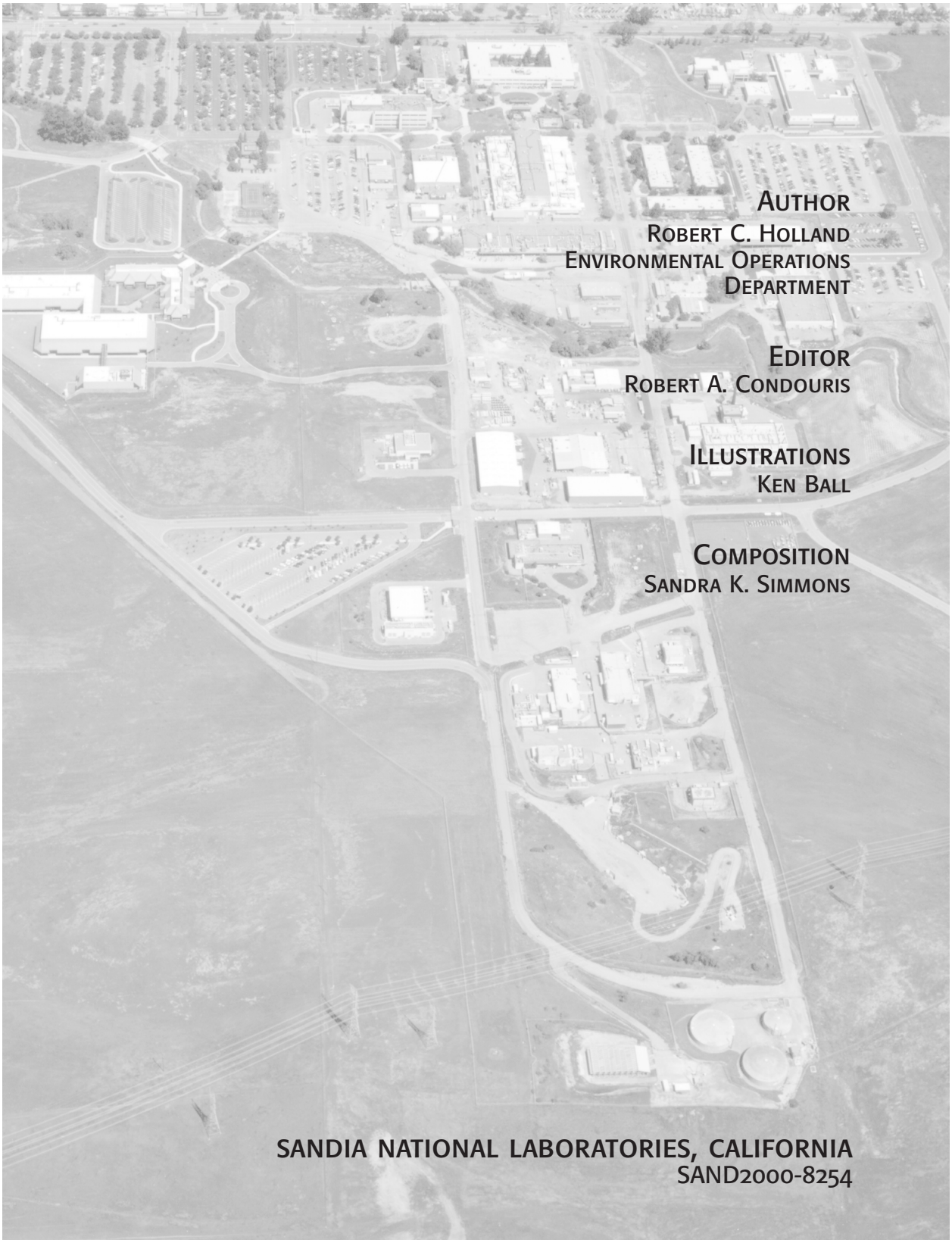

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PREFACE

The U.S. Department of Energy (DOE) Order 5400.1, General Environmental Protection Programs, establishes requirements for environmental protection programs at DOE sites, including Sandia National Laboratories (SNL). These programs ensure that DOE operations comply with Federal, State, and local environmental laws and regulations, as well as DOE orders and policies. To comply with DOE Order 5400.1, SNL, California has prepared the *Environmental Protection Implementation Plan*.[1] This document provides the framework for SNL, California to implement the DOE's environmental protection goals and to comply with environmental regulations.

To verify effective protection of the environment, SNL, California maintains extensive effluent monitoring and environmental surveillance programs. These programs collect the information necessary to assess how effective pollution control measures are and to characterize the site's impact on the environment. The monitoring program routinely measures the levels of pollutants and radioactive material around the Sandia site and surrounding area. The off-site environmental radiation monitoring data in this report were collected by Lawrence Livermore National Laboratory (LLNL), which monitors outlying areas for both facilities. The SNL, California *Environmental Monitoring Plan* identifies the operations and emissions at the site and describes the effluent monitoring and environmental surveillance programs and activities. These programs and activities are in place to protect the public and the environment. The plan describes exposure pathways (potential routes of human exposure to pollutants), sampling and analysis procedures, radiation dose assessment methods, and quality assurance activities.

The SNL, California Environmental Operations Department is responsible for all-environmental programs and activities, including reporting requirements. Environmental staff maintain various documents describing specific program areas. These documents are referenced in this report, as appropriate.

The SNL, California Environmental Operations Department prepares the *Site Environmental Report* annually, as required by the DOE and other regulatory agencies. It describes the results of SNL, California's environmental protection activities during the calendar year. It also summarizes environmental monitoring data and highlights major environmental programs. Overall, it evaluates SNL, California's environmental management performance and documents the site's regulatory compliance status.

Most importantly, the Site Environmental Report serves the needs of the public. It is a key element in our communication with the local community. For this reason, the report contains two summary chapters: Chapter 1, "Executive Summary," and Chapter 3, "Compliance Summary," which highlight and interpret environmental findings and regulatory compliance for the year. These summaries are written for the lay person and use a minimum of technical terminology. We have also included an extensive glossary in the back of the report. It defines acronyms, abbreviations, and technical terms. It also describes radiological nomenclature and conversion information for units used in the report.

The body of the report is a comprehensive description of environmental activities. It provides substantial background information and covers all major environmental programs at SNL, California.

REFERENCES

1. R. C. Holland, Environmental Monitoring Plan, Sandia National Laboratories/California, SAND95-8001 (March 1998).

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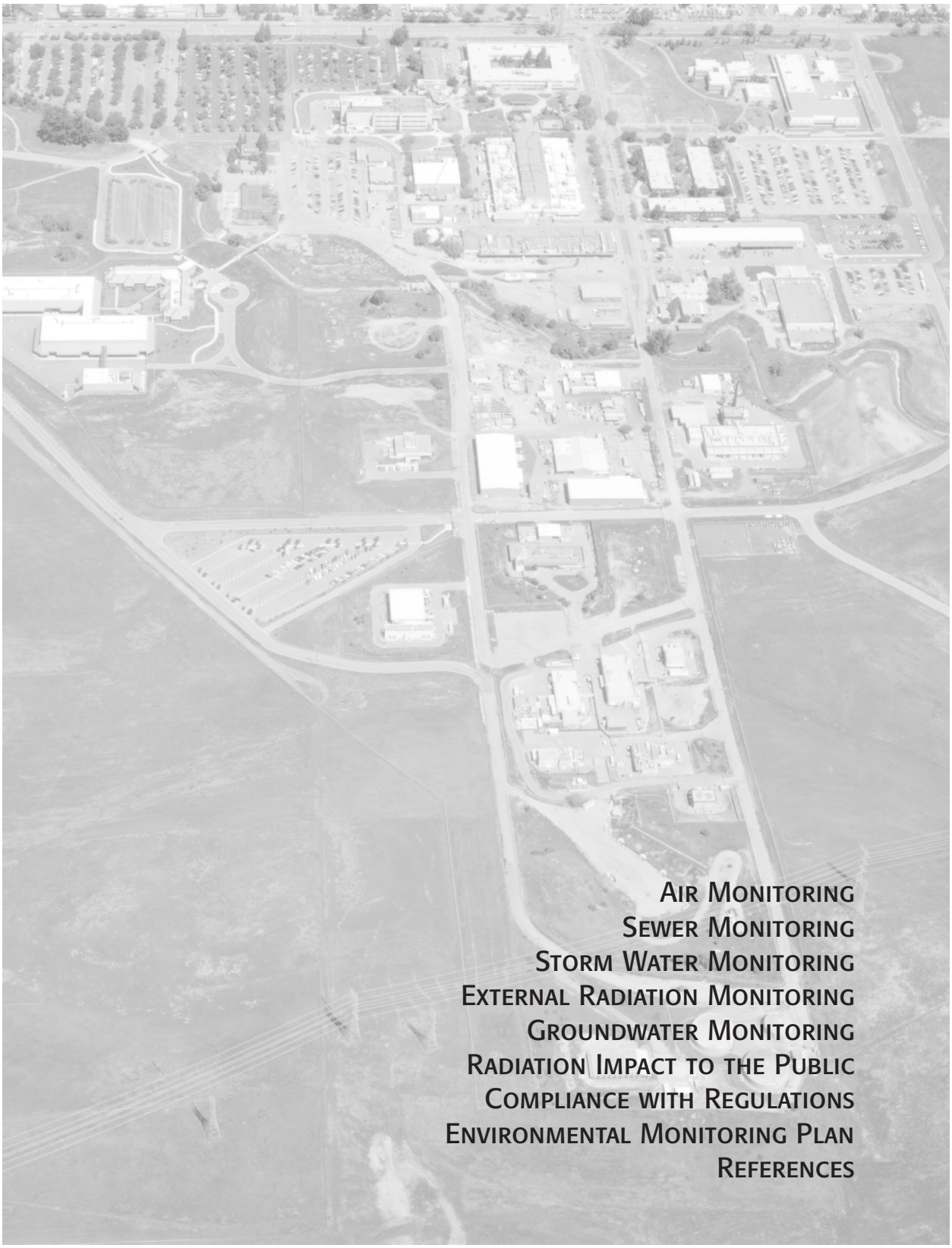


The U.S. Department of Energy (DOE) oversees operation of Sandia National Laboratories, California (SNL, California) through the Kirtland Area Office (KAO), which reports to the Albuquerque Operations Office. This report was prepared in accordance with DOE Order 5400.1, "General Environmental Protection Program." The report summarizes data from the environmental protection and monitoring program at SNL, California through December 31, 1999. It also discusses SNL, California compliance with environmental statutes, regulations, and permit provisions and highlights other significant environmental programs and efforts at SNL, California. This report is a key component of the DOE's effort to keep the public informed about environmental conditions throughout the DOE complex.

The DOE/KAO and Sandia Corporation are committed to conducting its operations in an environmentally safe and sound manner. It is mandatory that activities at SNL, California comply with all applicable environmental statutes, regulations, and standards. Moreover, SNL, California continuously strives to reduce risks to employees, the public, and the environment to the lowest levels reasonably possible.

To help verify effective protection of public safety and preservation of the environment, SNL, California maintains an extensive, ongoing environmental protection program. This program monitors all significant effluents from the SNL, California site. Lawrence Livermore National Laboratory (LLNL) performs offsite external radiation monitoring for both sites. These efforts ensure that emission controls are effective in preventing contamination of the environment.

As part of SNL, California's Environmental Protection Program, an environmental surveillance system measures the possible presence of hazardous materials in groundwater, storm water, and sewage. The program also includes an extensive environmental dosimetry program, which measures external radiation levels around the Livermore site and nearby vicinity.

Each year, the results of the Environmental Protection Program are published in this report, the *Site Environmental Report*. This executive summary focuses on impacts to the environment. Chapter 3, "Compliance Summary," reviews the site's various environmental protection activities and compliance status with applicable environmental regulations.

The effluent monitoring and environmental surveillance results for 1999 show that SNL, California operations had no harmful effects on the environment or the public. A summary of the monitoring findings is provided below.

AIR MONITORING

SNL, California has no routine emissions of radioactive materials to the air, and therefore does not perform ambient air monitoring. Air monitoring data for radionuclides performed by LLNL in the vicinity of the site can be obtained in the LLNL *Environmental Report 1999*.

SEWER MONITORING

The sanitary sewer effluent from the SNL, California site is monitored continuously and analyzed weekly to ensure compliance with Federal, State, and local wastewater discharge limits. Moreover, SNL, California strives to minimize pollutants in liquid effluents to the lowest levels possible.

In 1999, all liquid effluent from the Sandia sanitary sewer outfall complied with the site outfall discharge limits for regulated physical parameters, metals, radionuclides, and Environmental Protection Agency (EPA) priority organic pollutants.

SNL, California also has a special monitoring program for "categorical processes" subject to EPA wastewater

pretreatment standards [Title 40 Code of Federal Regulations (CFR), Parts 433 and 469].[1] In 1999, all the liquid effluents from these processes complied with pretreatment discharge standards for metals and organic pollutants.

The DOE and the State of California have established allowable limits for discharging radionuclides into a public sewer system (see Chapter 4).[2] These limits have been derived to protect the public and the environment. The current discharge permit issued by the City of Livermore requires SNL, California to sample the sewer effluent for tritium only during heavy rainfall events. During 1999, no samples were analyzed for tritium. Details of the Sanitary Sewer Monitoring Program may be found in Chapter 4, "Environmental Monitoring Program."

STORM WATER MONITORING

A State-issued industrial storm water National Pollutant Discharge Elimination System (NPDES) general permit and Alameda County storm water ordinances require SNL, California to effectively eliminate non-storm water discharges and reduce pollutant discharge in rain to the storm drain system to the maximum extent practicable. To comply with these requirements, SNL, California conducts a variety of sampling and inspection activities throughout the year. Storm water runoff is sampled and visually inspected during the wet months. The entire site is inspected quarterly during dry weather for non-storm water discharges. The site is again inspected annually to evaluate that on-site outdoor activities minimize the amount of pollutants left on the ground, which can enter by storm water runoff into the storm drain system.

In 1999, samples were collected from all of the 10 sampling locations. Every effort was made to collect samples within the first 30 minutes of a storm, or as soon as possible thereafter.

No regulatory limits have been set for pollutants in storm water runoff. No pollutants were detected at levels that would be a cause for concern during the 1999 sampling. The analyses for the storm water runoff included metals, toxic organics, tritium, and physical parameters. Details of the Sanitary Sewer Monitoring Program may be found in Chapter 4, "Environmental Monitoring Program."

EXTERNAL RADIATION MONITORING

SNL, California and LLNL conduct an extensive program to measure external radiation doses at the Livermore site perimeter and throughout the Livermore Valley.

In 1999, the average annual dose, equivalent from external radiation measured at the Livermore site perimeter was 58.7 mrem (0.59 mSv). This level was essentially the same as the background radiation dose measured off-site: 57.8 mrem (0.58 mSv). These measurements demonstrate that no measurable external dose was the result of direct radiation from SNL, California operations during 1999. That is, if a person had resided at the site fence line 24 hours a day, every day in 1999, he or she would not have received any measurable dose of external radiation above the natural background level. Details of the Sanitary Sewer Monitoring Program may be found in Chapter 4, "Environmental Monitoring Program."

GROUNDWATER MONITORING

SNL, California conducts groundwater monitoring in areas of known contamination, areas of past contamination (that have been cleaned-up), and areas thought to be able to provide early warning of contamination.

Maximum Contaminant Levels (MCLs) were exceeded for components of diesel fuel at the Fuel Oil spill site; the MCL for carbon tetrachloride was exceeded at the closed Navy Landfill Site; and

the MCLs for several metals and nitrate were exceeded at MW-406. Since the MCLs are drinking water standards, none of the wells at SNL, California sample aquifiers used for drinking water supplies, these exceedances are not considered significant. SNL, California reports all ground water monitoring results to the appropriate state agency. Details of the ground water monitoring program may be found in Chapter 6, "Groundwater."

RADIATION IMPACT TO THE PUBLIC

All use of radionuclides at SNL, California with a potential for release of radioactive materials to the air are evaluated and compared to regulatory limits. If required by regulation, dose assessments are performed. No dose assessments were required during 1999. SNL, California does not perform operations with the potential for release of radioactive material to water.

COMPLIANCE WITH REGULATIONS

SNL, California expends considerable effort to make sure that site operations comply with all applicable Federal, State, and local regulations. The environmental monitoring data demonstrate that all emissions to the environment from SNL, California in 1999 were well within regulatory standards. For details of SNL, California's compliance record, see Chapter 3. It summarizes SNL, California's compliance with applicable environmental statutes and regulations for 1999 and discusses current issues related to environmental management.

ENVIRONMENTAL MONITORING PLAN

SNL, California prepared the *Environmental Monitoring Plan* in accordance with DOE guidelines.[3] The plan serves as a guidance document for the Environmental Monitoring Program at SNL, California. The Site Environmental Report provides the results of the Environmental Monitoring Program activities for the year.

The *Environmental Monitoring Plan* contains a comprehensive review of environmental monitoring at SNL, California, including administrative structure, pathway analysis, effluent monitoring, sampling of environmental media, laboratory procedures and quality assurance. It details the operations of each of these areas and documents the rationale behind the diverse monitoring methods. In addition to documenting the monitoring system, the plan provides an in-depth review of the adequacy and scientific defensibility of SNL, California's monitoring program.

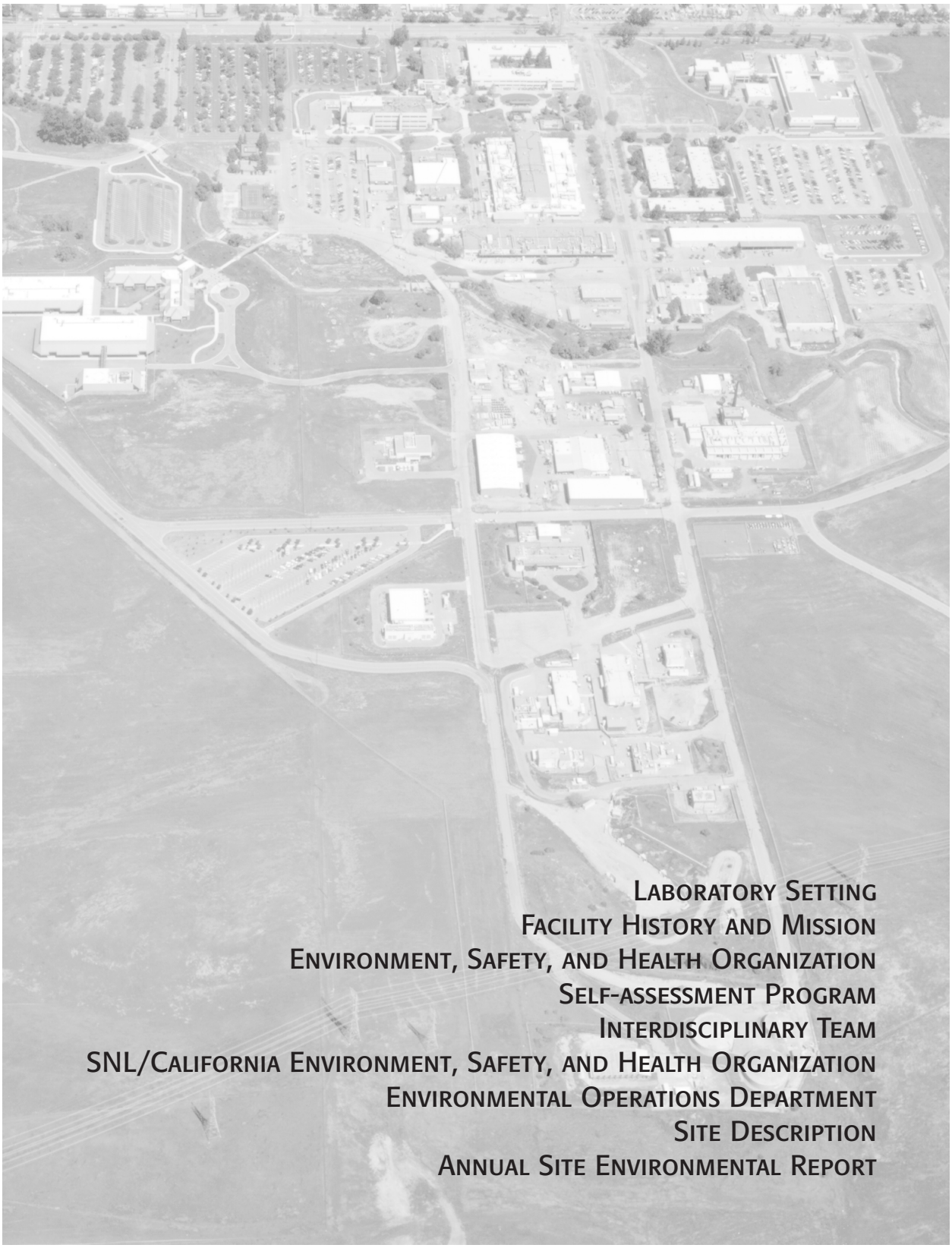
REFERENCES

1. U.S. EPA, Title 40 CFR, Parts 433 and 469, *Metal Finishing Point Source Category and Electrical and Electronic Components Point Source Category*.

2. State of California, *California Code of Regulations*, Title 22, Sections 64400 et seq., "California Domestic Water Quality and Monitoring" (1995).

3. R. C. Holland, *Environmental Monitoring Plan*, Sandia National Laboratories/California, SAND93-8011B (February 1997).

2 — Introduction



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Facility History and Mission
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Site Description
Annual Site Environmental Report

Sandia National Laboratories, California (SNL, California) is a government-owned, contractor operated facility. The Department of Energy (DOE) oversees operation of SNL, California through the Kirtland Area Office (KAO), which reports to the Albuquerque Operations Office.

LABORATORY SETTING

SNL, California is located next to the City of Livermore (population approximately 60,000), in eastern Alameda County, 65 km (40 miles) east of San Francisco (see Fig. 2-1). The central site area is surrounded on all sides by undeveloped land, which serves as a buffer zone. The site lies at the western base of the Altamont Hills. To the north is Lawrence Livermore National Laboratory (LLNL), and further north is an expanding business park and commercial development. The property to the south and east of the site comprises agricultural and low-density residential areas. Although principally residential, the area to the west encompasses a wide range of uses, which include a business park, grazing lands, vineyards, and other small agricultural and industrial developments.

FACILITY HISTORY AND MISSION

Sandia Corporation, a wholly owned subsidiary of the Lockheed Martin Corporation, has been the operating contractor of Sandia National Laboratories (SNL) since 1993. As the primary management contractor, Sandia Corporation is responsible for the site's operations; environment, safety, health, and quality assurance; and all of the site's administrative functions.

SNL consists of facilities in New Mexico, California, Nevada, and Hawaii. As one of the United States' multipurpose national laboratories, SNL develops solutions to a wide range of problems facing the country. With the end of the Cold War, SNL's traditional national security mission has expanded to include advanced military technology, energy and environmental research, arms control/nonproliferation, and advanced manufacturing technologies. In addition, Sandia is involved in both technology transfer and educational outreach.

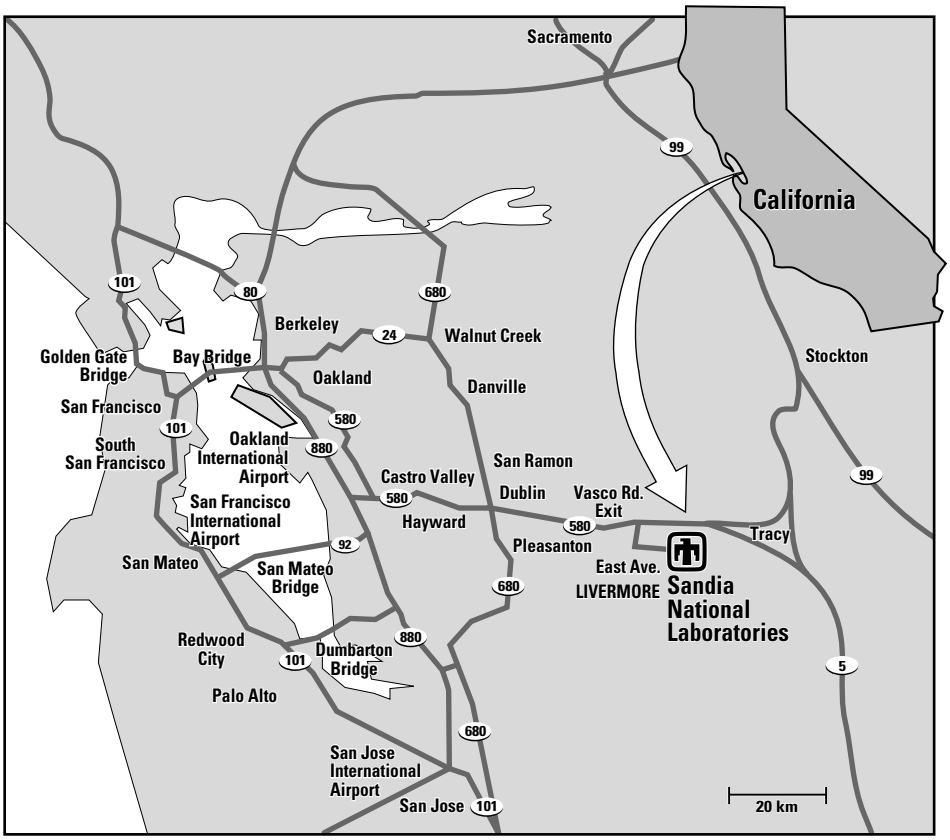


Figure 2-1. SNL, California in a regional setting.

Operations at SNL's California facility comprise three broad programmatic areas:

National Security: National security programs involve both nuclear and nonnuclear work. National security activities encompass maintaining the safety, security, and reliability of the nuclear weapons stockpile as well as nonproliferation of weapons of mass destruction and counter proliferation (that is, response to proliferation).

Energy and Environmental Research: This research addresses a broad range of initiatives centered on combustion science and technology. Areas of emphasis include energy resources for a cleaner environment, minimization of the environmental impact of transportation, environmental remediation and pollution prevention, and renewable energy resources.

Integrated Manufacturing Technologies: This program uses the systems and technology at the site to develop advanced manufacturing techniques, including simulation-based design, concurrent engineering, rapid prototyping technologies, intelligent machines for hazardous and flexible operations, engineered processes and materials, environmental protection and control, and an infrastructure to support product realization. Our aim is to be an agile manufacturing test bed for low-cost prototypes and development.

SNL, California incorporates the highest regard for environment, safety, and health (ES&H) into every experiment and all site operations. SNL, California operates under the scope of federal, state, and local regulatory authorities and has obtained all appropriate operating permits. Sandia is committed to operate in full compliance with the letter and spirit of applicable environmental laws, regulations, and standards. Furthermore, SNL, California strives to go beyond compliance with legal requirements by making every effort practical to reduce impacts to the environment to levels as low as reasonably achievable.

ENVIRONMENT, SAFETY, AND HEALTH ORGANIZATION

SNL, California has established a corporate-level ES&H organization. The Sandia Corporation president has overall responsibility for ES&H. Together, they are ultimately responsible for establishing and communicating a corporate culture that considers the protection and preservation of the environment and the safety and health of its personnel, contractors, visitors, and the public, to be critical to Sandia's success.

SNL, California has an ES&H organization to carry out the corporate ES&H vision. Its structure is shown in Fig. 2-2. This organization implements ES&H programs and ensures compliance with regulations specific to the SNL, California.

To help assure that ES&H commitments are fulfilled, SNL, California has established a Sandia, California ES&H Council (SCEC). The SCEC ensures top-level management involvement in developing and monitoring ES&H goals. It establishes, promotes, and communicates a culture that recognizes ES&H as a top priority at SNL, California. The SCEC also provides leadership and consistency of approach in the SNL, California ES&H program. It provides a mechanism for organizational communication—both horizontally and vertically.

The SNL, California Safety, Health and Environment Appraisal Committee provides the SNL, California vice president with an assessment of the SNL, California's Site's operational ES&H status. The committee assesses the SNL, California Site to assure that procedures are being properly implemented to pro-

vide a safe and healthful workplace, protection of the environment, and protection of property against loss and damage due to accidents. It plays an essential role in setting ES&H goals, and promoting and communicating the high priority Sandia places on environment, safety, and health.

The ES&H departments provide oversight of management-related ES&H activities and provides direct ES&H assurance information to the SNL, California vice president for the SNL, California Site. The departments ensure uniform implementation of corporate ES&H management processes through the use of organizational ES&H coordinators. Additionally, the departments conduct internal audits and self-assessments of the SNL, California's ES&H management processes.

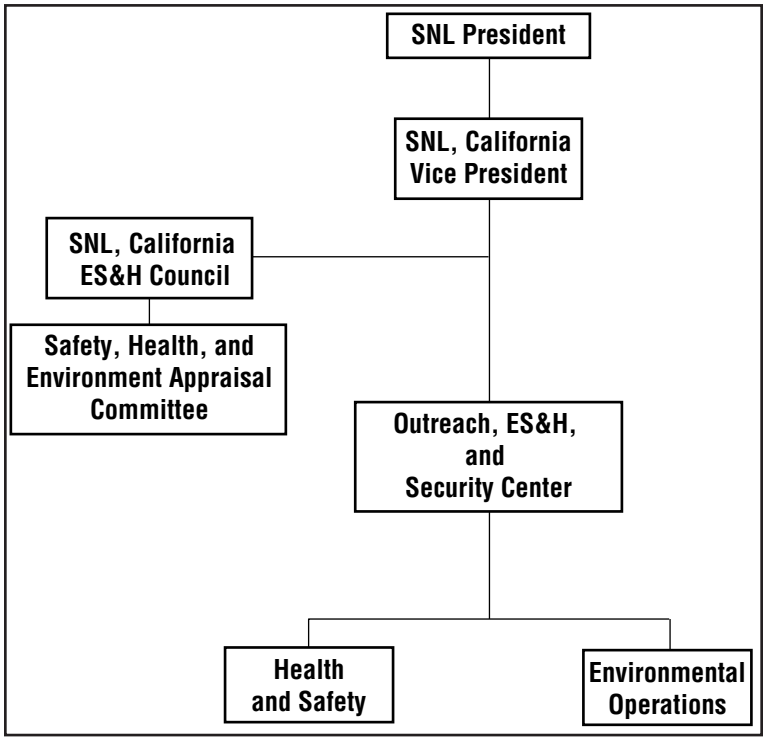


Figure 2-2. Organizational structure of environment, safety, and health at SNL, California.

SELF-ASSESSMENT PROGRAM

SNL, California ES&H Self-Assessment process was implemented as part of feedback and improvement of Division 8000's Integrated Safety Management System (ISMS) in April 1998. The ES&H Self-Assessment process falls under the umbrella of Chapter 22 of the *ES&H Manual*. Sandia California's *ES&H Self-Assessment Operating Procedure* (OP471726) documents its process elements: responsibilities, planning, scheduling, information gathering, tracking, verifying, analyzing, evaluating, and reporting. The annual planning for ES&H Self-Assessments at SNL, California is completed by November 15 of each year and annual assessments begin January of each calendar year. Management Surveillances and Management Inspections are both encompassed in Sandia California's ES&H Self-Assessment process.

The site's self-assessment activities assess both line implementation and ES&H functional programs. ES&H Safety Committees and managers primarily perform Line Implementation Self-Assessments. The SNL, California ES&H Subject Matter Experts (SMEs) perform Functional Program Self-Assessments. The use of Quality Assurance, Sandia/New Mexico SMEs, independent contractors, or other DOE laboratory personnel is allowed.

SNL, California's ES&H Self-Assessments are conducted both annually and over a 3-year period. Management Self-Assessments are conducted such that all workspace is assessed annually for ES&H concerns by a team consisting of the responsible Manager, and an ES&H Coordinator. Safety Committee Self-Assessments are primarily made up of line staff and an SME. They are conducted, at a minimum quarterly, such that a sampling of operations onsite is reviewed at least every 3 years, unless required otherwise. Functional Program Self-Assessments are conducted such that a sampling of each program element is assessed at least every 3 years, unless required otherwise. Each Functional Program Self-Assessment is conducted within a 7-workday

time frame to ensure that other program responsibilities can be met.

Findings generated by SNL, California's ES&H Self-Assessments are documented in the site's audit database. Corrective actions are tracked in the site's web-based tracking database. Managers are responsible for tracking and closing out corrective actions in the site's web-based tracking database. Communication of corrective actions at the worker level is the manager's responsibility.

The self-assessment results are reported to SNL, California's Safety Health and Environment Appraisal Committee (SHEAC) quarterly. Annually, the data is reported to SHEAC for review of strengths, weaknesses, and trends. The results of SNL, California's ES&H Self-Assessments are also included quarterly in the Corporate ES&H Report. CY99 data establish SNL, California's ES&H self-assessment baseline. Broad general results of the assessments in CY99 include:

- 100% of the self-assessments scheduled in the site's CY99 Annual Self-Assessment Plan was conducted, documented, and tracked.
- 359 of the 467 findings identified as of 12/31/99, were closed, 68 were open, and 40 were overdue.

The objectives of SNL, California's ES&H Self-Assessments are to measure improvement in the implementation of the Integrated Safety Management System (ISMS) and to help ensure that the SNL, California meets the Corporate Performance Objectives:

- protect the people,
- protect the environment,
- comply with regulations, and
- use good management practices.

Interdisciplinary Team

The ES&H Interdisciplinary Team (IDT) is comprised of representatives from each of the primary disciplines within ES&H. The IDT is responsible for helping SNL, California's project teams consider ES&H issues as they plan and implement new projects or change ongoing projects. By reviewing proposed projects early in the planning stages, the Interdisciplinary Team helps to ensure projects and experiments are conducted safely and on schedule.

SNL, California Environment, Safety, and Health Organization

The organization responsible for ES&H at SNL, California is the Outreach, ES&H, and Security Center. An important part of the center's mission is to ensure the health and safety of SNL, California employees and the general public, and to protect the environment. This mission is fulfilled by helping SNL, California employees understand and comply with DOE orders and their legal responsibilities under federal, state, and local laws and regulations. The Outreach, ES&H, and Security Center has two departments involved in ensuring workplace safety and protection of the environment: Health Protection, and Environmental Operations.

The Environmental Operations Department is responsible for ensuring that operations at SNL, California are conducted in an environmentally responsible manner and in compliance with applicable laws and regulations. Department personnel contribute their expertise and services to guide and support other SNL, California departments in achieving their missions and goals. They are directly responsible for this report and the activities described herein. Therefore, their specific responsibilities are described below.

Environmental Operations Department

The Environmental Operations Department maintains a variety of programs to monitor the environmental impacts of site emissions, to preserve the quality of

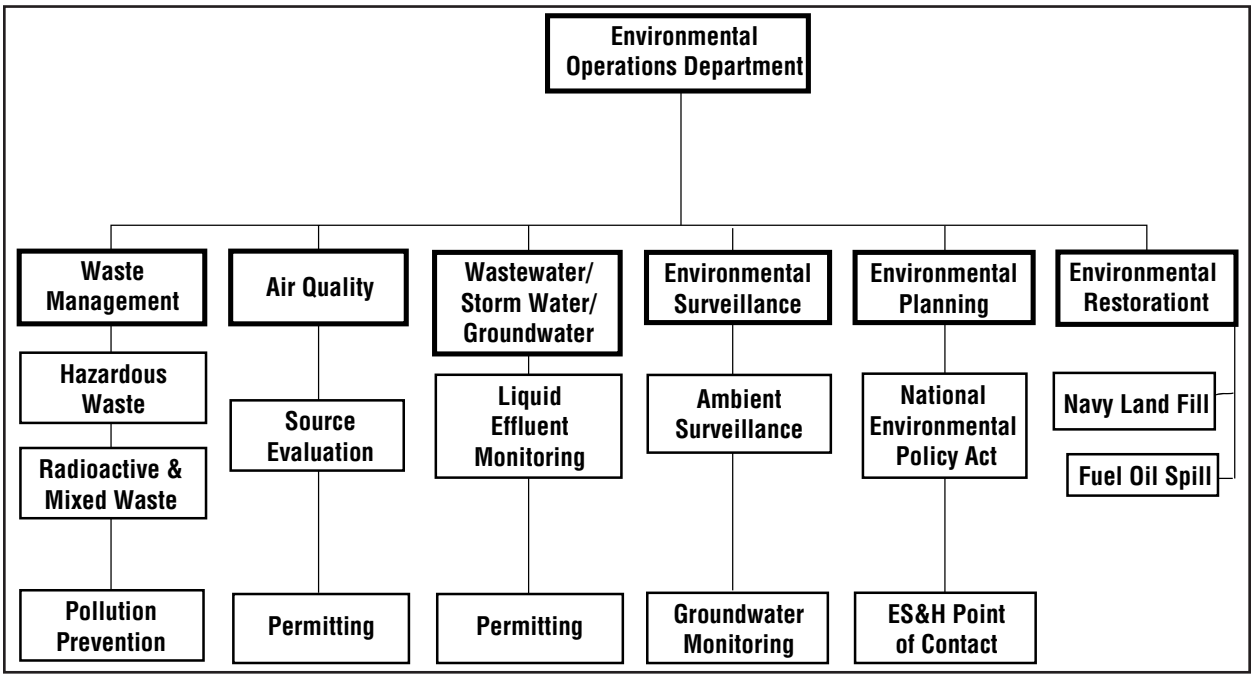


Figure 2-3. Organizational structure of the Environmental Operations Department.

the environment, and to properly manage (minimize and dispose of) hazardous waste. To fulfill its mission, the department has groups responsible for waste management, pollution prevention, environmental surveillance, air quality, environmental planning, and wastewater/storm water management (Fig. 2-3). The following sections briefly describe the activities of these groups.

Waste Management

The Waste Management Program is responsible for managing radioactive, mixed, medical, energetic, and hazardous wastes. Waste management activities include the collection, onsite transport, storage, treatment, packaging, and shipment of wastes in accordance with DOE, Environmental Protection Agency (EPA), and state-specified regulations and requirements. The group also manages the following Waste Management Program activities: training, permitting, reporting, interfacing with regulators through the DOE, program planning, record keeping, and budgeting.

The Waste Management Group is responsible for operations conducted in the Hazardous Waste Storage Facility, and the Radioactive and Mixed Waste Storage Facility. In addition, the group manages the permitting of two on-site neutralization facilities that are regulated under "tiered permitting."

Pollution Prevention

The Pollution Prevention Program is responsible for promoting pollution prevention and source reduction of all wastes in all site activities. Responsibilities include:

- gathering process information,
- assisting in and evaluating pollution prevention,
- fostering employee awareness of pollution prevention and source reduction issues and technologies, and
- developing and maintaining site recycling programs.

The Pollution Prevention Program also is responsible for preparing reports to the DOE and to federal, state, and local regulators. SNL, California has a waste-

minimization/pollution-prevention coordinator to manage these efforts.

Environmental Restoration

The Environmental Restoration Program is responsible for assessing the extent of historical contamination of SNL, California sites and managing any necessary restoration efforts.

Environmental Surveillance/Compliance Groundwater Monitoring

The Environmental Surveillance Program at SNL, California assesses potential impacts to the public and the environment from site operations. The group is responsible for ensuring that SNL, California complies with federal, state, and local regulations and with DOE orders governing protection of the environment. Specifically, environmental surveillance personnel maintain a direct radiation monitoring system. The Program also ensures SNL, California's compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAPs) Rule for Radionuclides, under the Federal Clean Air Act (CAA), and DOE orders.

The group also performs computer modeling of potential emissions to document compliance with these regulations. The group uses these systems to monitor the general environment of SNL, California and nearby vicinity to verify that emission controls are effective in preserving the local environs.

This group is also responsible for the monitoring of groundwater in compliance with state regulations.

The group also prepares numerous reports and other documents to demonstrate compliance.

Air Quality

The Air Quality Program manages a program to facilitate site compliance with regulations governing air emissions to the environment. The Air Quality Compliance Program maintains the site air emissions inventory and evaluates Sandia operations that are potential sources of air pollutants.

Chemical Information Management (Health & Safety Department)

The Chemical Information Management Program is responsible for providing consultation for chemical analysis and data review and for maintaining the site-wide Chemical Information System/Material Safety Data Sheet (MSDS) system. This system is a relational database containing comprehensive information for tracking chemicals used at SNL, California. It includes a site-wide chemical inventory of more than 40,000 bar-coded chemical containers and potential, personnel chemical-exposure data. The system also manages more than 60,000 MSDS, which are available to all site personnel on the SNL Internal Web. The system includes hazardous, radioactive, and mixed waste tracking information.

Environmental Planning

Elements of the Environmental Planning Program include National Environmental Policy Act (NEPA) compliance, California Environmental Quality Act (CEQA) compliance, biological and cultural resource issues, and facilitation of the ES&H Interdisciplinary Team (IDT) process. The Environmental Planning Program provides guidance to all SNL, California organizations in meeting NEPA, CEQA, and IDT requirements. Additionally, the Program tracks and oversees issues associated with biological and cultural resource management. Other responsibilities of the Environmental Planning Program include evaluating potential ES&H effects of new and continuing projects at SNL, California; interfacing with DOE on all NEPA, biological, and cultural resource issues; and serving as the point of contact for the ES&H Interdisciplinary Team.

Wastewater/Storm Water/Management

The Wastewater/Storm Water Management Program is responsible for ensuring that SNL, California complies with all federal, state, and local regulations and DOE orders regarding the quality of wastewater and storm water discharges. The group performs the following operations:

- Monitors these discharges both visually and through sampling and analysis.
- Verifies that wastewater and storm water discharges are in compliance with established standards and requirements.
- Prepares numerous reports, permit applications, and other documents to demonstrate compliance with various environmental regulations and DOE orders.
- Implements controls to ensure that SNL, California site activities do not impact the quality of surface waters in the vicinity or in the San Francisco Bay (to which site storm water drains).

SITE DESCRIPTION

This section provides an overview of the SNL, California site, the physical environment, and the ecological characteristics of the area.

Laboratory Facility

The SNL, California site covers 1.7 km^2 (413 acres), which includes 213 acres of developed areas. In 1986 and 1987, the DOE acquired 228 acres to provide a security buffer zone between developed areas and the Laboratory.

The site facilities comprise approximately 74,400 m^2 (801,000 ft^2) of building floor space. Of this, about 31% is office and drafting areas, 48% is light laboratories and shops, and 3% is heavy laboratories (e.g., high-pressure test facilities and explosives chambers). The remaining 18% is classified as miscellaneous usage, such as computer rooms and library space.

Because SNL, California is a multiprogrammatic laboratory involved in a broad range of research and development, facilities are designed for small-scale scientific and applied engineering research. The site has neither production nor large-scale manufacturing operations.

Airborne Emissions

SNL, California has sources of uranium, principally depleted uranium. All operations with the potential to emit uranium are controlled by both administrative and physical controls. Any operation with the potential to emit radionuclides to the environment undergoes an evaluation in accordance with NESHAPs. Nonradiological emissions include nitrogen oxides (NO_x), particulates, and precursor organic compounds.

Water Supply and Sewer Effluent

The site's water supply normally comes from the Hetch Hetchy Aqueduct, which is supplemented occasionally by water from the Zone 7 Flood Control and Water Conservation District. Sandia's sanitary sewer effluent merges with the Lawrence Livermore National Laboratory (LLNL) sewer system, and the combined waste stream discharges to the City of Livermore sanitary sewer system at the northwest corner of the LLNL site. The sanitary sewer effluent from the SNL, California site (and from the rest of the Livermore area) is processed at the Livermore Water Reclamation Plant. After treatment, the wastewater is transported via pipeline to the San Francisco Bay. A portion of the treated effluent is reclaimed and used for local irrigation.

Topography

The Livermore Valley (Fig. 2-4) is an irregularly shaped lowland in the Diablo Range of the California Coastal Mountain Range. The valley is approximately 26 km

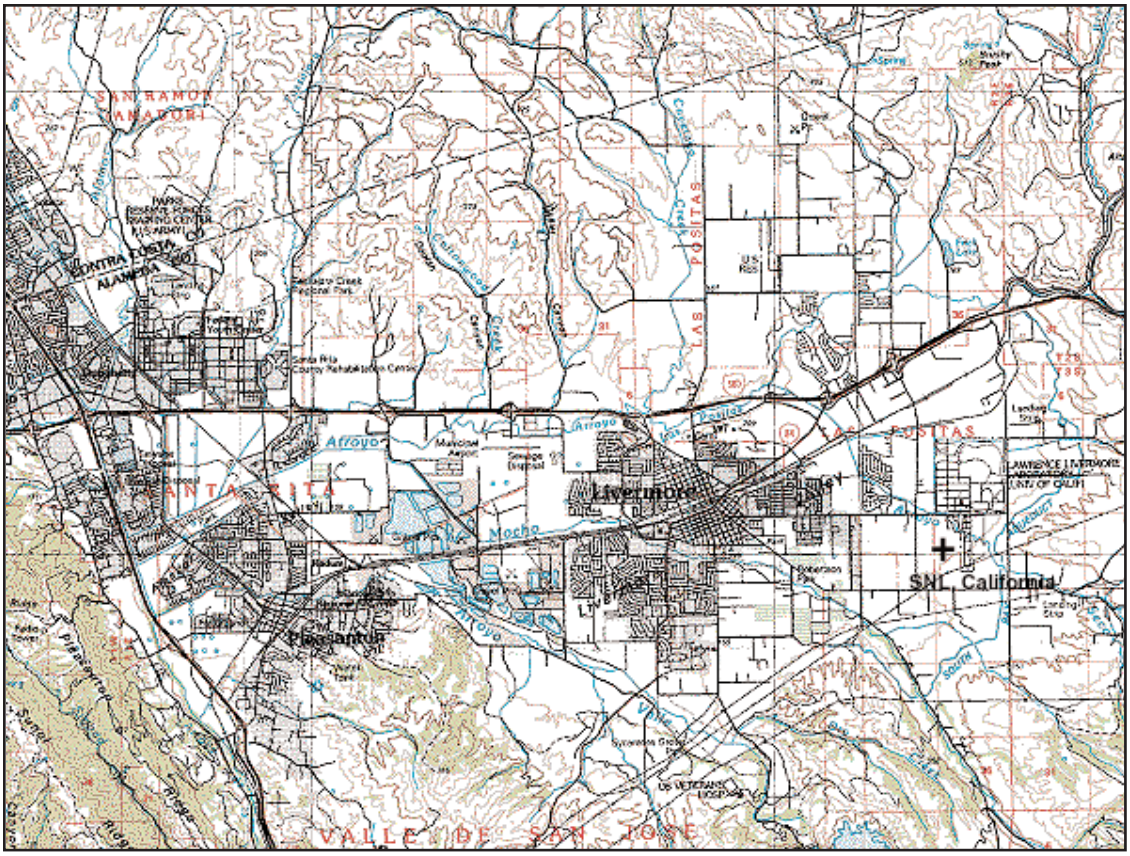


Figure 2-4. Topograpy of Livermore Valley. SNL, California is located at the in the pan handle just south of Lawrence Livermore National Laboratory.

(16 miles) long (east to west) and averages about 11 km (7 miles) wide. The valley floor slopes gently downward to the west at about 10 m/km (50 ft/mile). The elevation is approximately 200 m (660 ft) at the eastern boundary of the valley and 90 m (295 ft) at the southwest corner.

The topography of the California site is generally characterized by relatively flat areas at the northern portion of the site, hills to the south, and steep banks along the Arroyo Seco.

Geology and Hydrology

The Livermore Valley overlies a complex geologic region where ancient arroyos have deposited a heterogeneous mixture of sand, silt, clay, and gravel. These alluvial deposits create layers of higher and lower permeability overlying the older Livermore formation.

The groundwater of the Livermore Valley can be found in the more permeable layers, which lie between 5 and 33 m (17 and 110 ft) below the surface (Fig. 2-5). Groundwater in the Livermore Valley generally flows in a westerly direction. The groundwater movement underlying the SNL, California site is strongly influenced by the Las Positas Fault Zone. North of the fault, movement is generally westerly. South of the fault, the movement is less distinct, but appears to be radial from a groundwater mound.

Located in west-central California, the site is in a seismic region. The major faults are San Andreas, Hayward, Calaveras, and Greenville. The closest major faults are Calaveras—about 11 miles west of the site, and Greenville—about 2 miles east of the site. A small, locally active fault, the Las Positas Fault, runs through

the southern portion of the site.

Intermittent streams (arroyos) flowing northwest carry surface drainage into the Alameda Creek near Sunol, which continues west to the San Francisco Bay. The Arroyo Seco crosses the site from the southeast to the northwest. Storm water runoff from the hills to the southeast flows into the arroyo during the rainy season. The arroyo is dry the rest of the year. The SNL, California site storm sewer system also channels storm water into the Arroyo Seco. This system is the main pathway for the site's surface drainage.

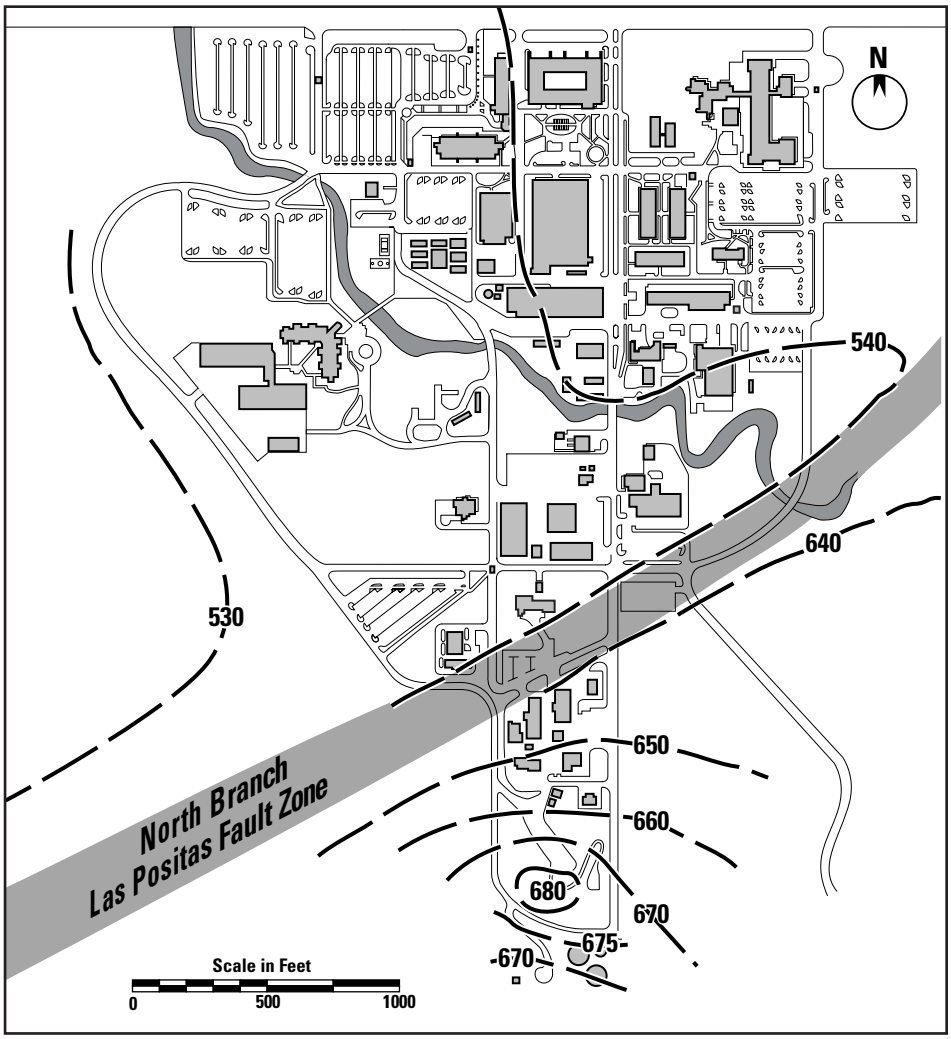


Figure 2-5. Typical groundwater contours at SNL, California.

Climate and Meteorology

The climate of the Livermore Valley consists of mild, rainy winters and warm, dry summers. The mean annual temperature is 12.5°C (55°F), with extremes ranging from 0° to 38°C (32° to 100°F). Rain falls primarily between October and April. Precipitation at the SNL, California site for calendar year 1999 was 25.58 cm (10.07 in.). The prevailing winds blow from the west and southwest from April to September. The winds are variable during the rest of the year.

Biological Resources

The Sandia site is separated into two distinct areas, developed and undeveloped. The developed area is landscaped and offers little habitat for local wildlife. The undeveloped area is typical of grassland in the local area, dominated by non-native grasses with an assortment of native herbs. The Arroyo Seco supports a wetland and riparian corridor in the eastern undeveloped portion of the site (see Fig. 2-6). Vegetation in the wetland/riparian area includes sycamore, cottonwood, and willow trees, patches of cattails, rush, mugwort, and creeping wild rye grass. The remaining portion of the Arroyo supports various native and non-native plant species such as valley oak, ornamental fruit trees, and eucalyptus.

The riparian corridor and open grassland in the undeveloped area of Sandia

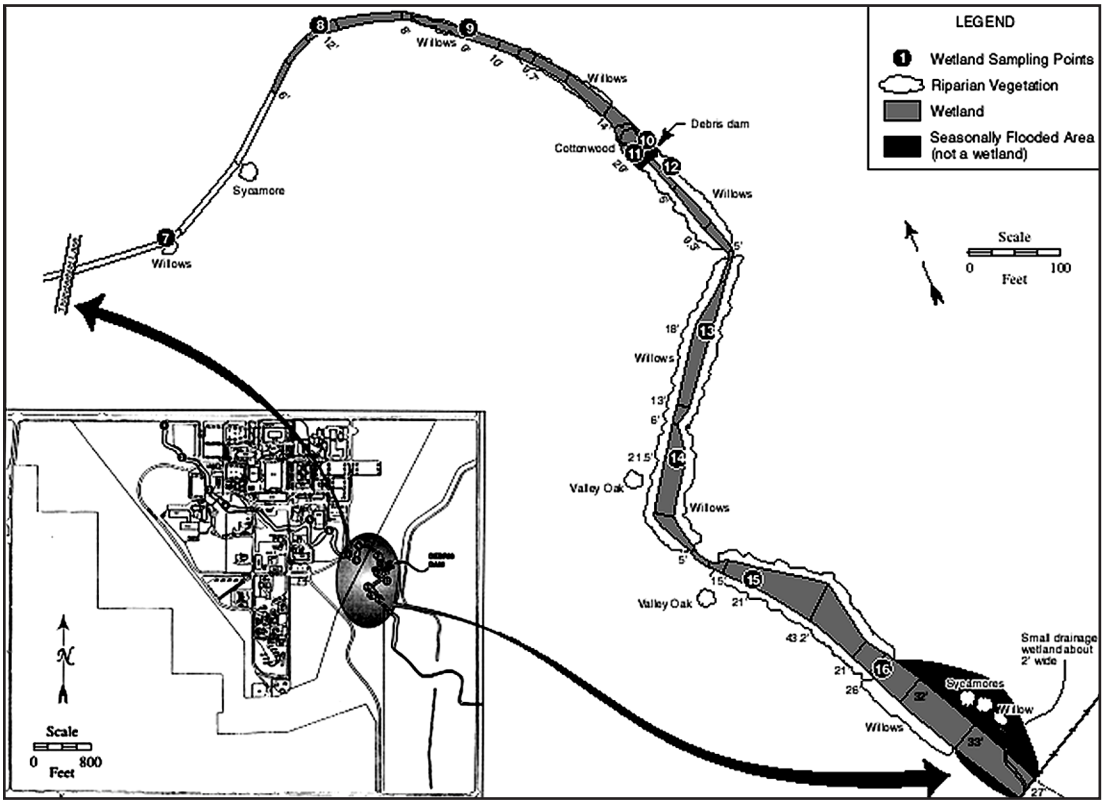


Figure 2-6. SNL, California wetland areas.

offers suitable habitat for several sensitive wildlife species. Sensitive bird species observed in the riparian corridor include the loggerhead shrike (*Lanius ludovicanus*) and white-tailed kite (*Elanus leucurus*). Ground squirrel (*Spermophilus beecheyi*) burrows located in the open grassland provide suitable habitat for California tiger salamanders (*Ambystoma tigrinum*) and Western burrowing owls (*Athene cunicularia*). Both tiger salamanders and burrowing owls have been observed in the western buffer area near the percolation ponds. The California tiger salamander is a candidate for listing under the Endangered Species Act, and the Western burrowing owl is a species of concern under Federal and State laws.

The above mentioned bird species are considered to be particularly at risk due to declining populations although all nesting native birds (except pest species) are protected under California Fish and Game Code.

Annual Site Environmental Report

This *Site Environmental Report* documents all SNL, California's significant environmental activities throughout the year. These include effluent and environmental monitoring, environmental restoration, and environmental protection activities. This report also evaluates SNL, California's compliance with applicable environmental requirements. It is prepared according to the requirements of DOE Order 5400.1.[1]

An extensive glossary at the end of this report defines commonly used acronyms and abbreviations, as well as other technical terms used in the body of the report. The International System of Units (SI) or metric system of measurements has been used, where feasible. A

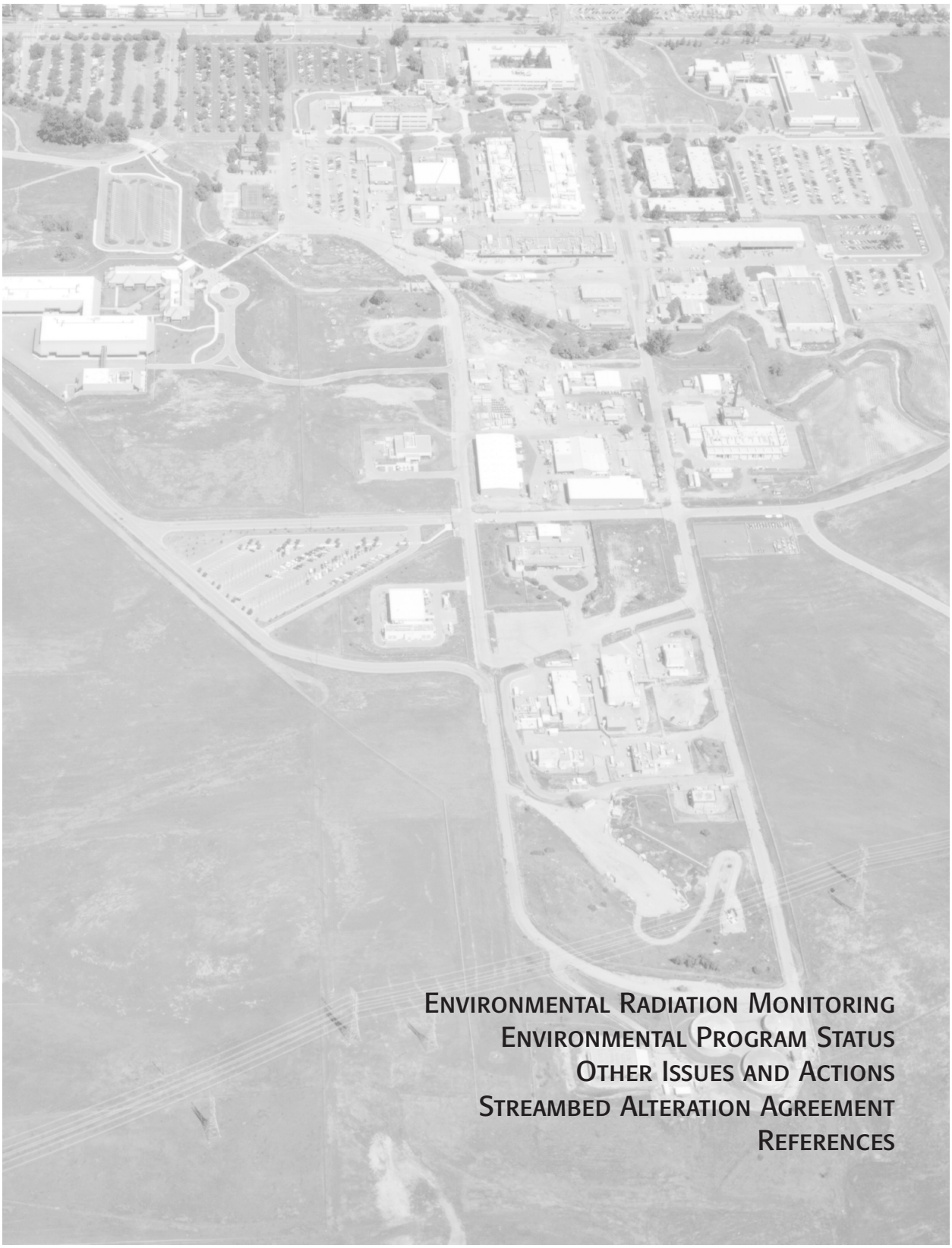
section on "Units of Measure" is included in the glossary as additional information about the system of units and quantities.

Appendix A contains laboratory procedures.

REFERENCE

1. U.S. DOE, Order 5400.1, *General Environmental Protection Program* (November, 1988, Change 1, June 29, 1990).

3 – Compliance Summary



The U.S. Department of Energy (DOE), Kirtland Area Office (KAO), and Sandia Corporation comply with all applicable Federal, State, and local environmental laws and requirements. In addition to meeting specific limits, SNL is obligated to keep emissions to the environment as low as reasonably achievable (ALARA).

Several Federal, State, and local government agencies are responsible for enforcing and overseeing environmental regulations at SNL, California. The principal agencies include the U.S. Environmental Protection Agency (EPA), the California Environmental Protection Agency (Cal/EPA), the Department of Health Services, the Department of Toxic Substances Control, the San Francisco Bay Regional Water Quality Control Board, the Bay Area Air Quality Management District, and the City of Livermore Water Reclamation Plant.

Table 3-1 summarizes the major Federal environmental statutes that apply to SNL, California operations. State and local authorities also impose a variety of environmental regulations.

This chapter summarizes SNL, California's environmental management performance and documents the site's compliance with these environmental statutes and regulations in 1999. It also discusses current environmental management programs. The compliance activities at SNL, California are administered by the Environmental Operations Department.

ENVIRONMENTAL RADIATION MONITORING

The Environmental Operations Department at SNL, California maintains an environmental surveillance program to verify the effectiveness of emission control procedures and to measure directly any effects on the environment. Sampling includes a network of environmental dosimeters used to measure external radiation levels. The environmental surveillance data collected during 1999 demonstrate compliance with Environmental Protection Agency (EPA) and DOE standards.

The environmental monitoring data collected in 1999 demonstrate that operations at SNL, California had no harmful effects on the environment or the public. SNL, California's emissions to the atmosphere during the year complied with all applicable Federal, State, and local environmental laws and standards.

ENVIRONMENTAL PROGRAMS STATUS

Table 3-1 briefly summarizes the major Federal, State, and local environmental regulations that apply to SNL, California. They are described in detail below.

Table 3-2 identifies the environmental permits held by SNL, California in 1999 and the regulatory agencies responsible for enforcing the respective regulations and permit conditions.

Resource Conservation and Recovery Act and California's Hazardous Waste Control Law

During 1999, SNL, California's waste programs complied with all DOE Orders and Federal and State Regulations. Hazardous waste management activities at SNL, California include handling, packaging, storing, and shipping energetic, radioactive, mixed, and nonradioactive hazardous waste for offsite shipment. All SNL, California wastes are shipped offsite for treatment, storage, or disposal. No wastes are disposed at the SNL, California site premises.

Treatment performed onsite consists of: waste compaction to reduce volume, elementary neutralization, and consolidation/commingling of various low-volume waste streams at the Hazardous Waste Storage Facility for offsite shipment.

SNL, California does not generate transuranic or high-level radioactive

wastes. Except for liquids generated from scintillation counting (which have been sent offsite for incineration), mixed waste has previously been shipped to SNL, New Mexico for management. Any future mixed waste will be sent offsite for treatment and disposal.

SNL, California has an active Waste Minimization and Pollution Prevention Awareness Program, independent from the waste management group.

For further detail on waste management activities, see Chapter 5, "Environmental Program Information."

Chemical Waste Program

DOE/KAO holds a Cal/EPA Part B permit for the Hazardous Waste Storage Facility operations. It is effective from January 4, 1993, to January 4, 2003. The permit allows SNL, California to store hazardous waste and to conduct limited treatment activities.

Low-Level Radioactive Waste Program

The low-level radioactive waste management activities at SNL, California include collecting and encapsulation of some low-level radioactive waste streams, packaging, and storing radioactive waste.

The majority of low-level waste management efforts in 1999 involved preparing for shipment of low-level radioactive waste to the Nevada Test Site. Much of the waste generated this year was the result of a joint research and development project with Lawrence Livermore National Laboratory (LLNL) and building renovations and decontamination activities. Various types of uranium contaminated waste was generated and disposed of at the Nevada Test Site.

The DOE Nevada Operations Office audited the SNL, California low-level radioactive waste management program in February 1999. Based on the results of this review, SNL, California was granted provisional approval to continue to ship low-level radioactive waste streams to the Nevada Test Site.

Mixed Waste Program

SNL management decided to consolidate all cost, liability, and management activities associated with the management of mixed waste at the SNL, New Mexico facility. SNL, California has previously transferred all mixed waste generated onsite to the SNL, New Mexico site, with the exception of liquid, scintillation-counting wastes, which have been shipped to a treatment facility (mixed waste generated averages less than 0.4 m^3 per year).

Hazardous Waste Permits

The Cal/EPA issued a final Resource Conservation and Recovery Act (RCRA) "Part B" permit on December 4, 1992, for SNL, California to operate the Hazardous Waste Storage Facility. The permit is effective from January 4, 1993, to January 4, 2003.

As provided by the 1984 Hazardous and Solid Waste Amendments to RCRA, the Cal/EPA conducted a RCRA Facility Assessment in April 1991. The assessment report was issued in September 1991. The Cal/EPA revised this report and reissued it in March 1992.[1] It identified three "solid waste management units" at SNL, California: the Fuel Oil Spill, the Navy Landfill, and Miscellaneous Sites. However, because these units were being assessed and remediated as part of the San Francisco Bay Regional Water Quality Control Board Order, no corrective action was required by Cal/EPA.

All waste handling operations at SNL, California are conducted according to the most recent State and Federal regulations. For further information on SNL, California's Hazardous Waste Program, see Chapter 5, "Environmental Program Information."

Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability

Act (CERCLA) is Federal legislation. It establishes a program for cleaning up contaminated areas in the environment. Two SNL, California restoration sites are affected by the Act: the Fuel Oil Spill and the Navy Landfill. SNL, California is cleaning up or assessing these sites under the authority of the San Francisco Bay Regional Water Quality Control Board. The DOE Environmental Restoration Program funds this activity. Assessment and remediation activities are formally regulated under RCRA and are being done under State direction.

Pursuant to San Francisco Bay Regional Water Quality Control Board Orders 88-142 and 89-184[1,2] SNL, California was involved in one assessment during 1999: the Fuel Oil Spill. This is described in Chapter 5.

For further information on SNL, California's Hazardous Waste Program, see Chapter 5, "Environmental Program Information."

Superfund Amendments and Reauthorization Act Title III; Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right-to-Know Act (EPCRA)—also known as the Superfund Amendments and Reauthorization Act (SARA) of 1986, Title III—requires reporting of toxic chemical usage and releases. The purpose of this provision is to make information about potential environmental releases of toxic chemicals available to the public. In accordance with the requirements of the Act, SNL, California submits reports annually to the EPA, the State of California, and the LLNL Fire Department.

The following Emergency Planning and Community Right-to Know Act (EPCRA) reporting requirements applied to SNL, California during 1999:

- EPCRA 302-303 "Planning Notification" - Report prepared.
- EPCRA 304 "EHS Release Notification" - No report required.
- EPCRA 311-312 "MSDS/Chemical Inventory" -Report prepared.
- EPCRA 313 "TRI Reporting" - No report required.

In 1999, SNL, California had two substances that were reportable under Sections 311 and 312: No. 2 fuel oil (fire hazard) and liquid nitrogen (asphyxiator, compressed gas, and cryogenic).

In 1999, SNL, California had no chemical release incidents that required notification under Sections 304 and no reportable substances under Section 313, Toxic Release Inventory (TRI). A plot of the "top five," or five most-used EPCRA 313 listed chemicals at SNL, California, is shown in Figure 3-1. This figure illustrates that SNL, California operations use far less than the 10,000 pound reporting threshold and represent a very minor Toxic Release Inventory source.

Hazardous Materials Release Response Plans and Inventory Law

The Hazardous Materials Release Response Plans and Inventory Law (California Law AB2185) covers the management of hazardous and acutely hazardous materials in the State of California. Additional state laws—AB2187, AB3777, AB3205 AB2189—and other bills modifying the state hazardous materials program are codified in the California Health and Safety Code Division 20, Chapter 6.95 §25500, et seq. SNL, California annually reviews and submits a California Hazardous Material Management Plan in accordance with the Hazardous Materials Release Response Plans and Inventory Law (and modifying laws) to the Alameda County Environmental Health Department, Hazardous Material Program.

DOE/KAO and SNL, California also submitted an Acutely Hazardous Materials Registration Form HM 3777 as required by the California Health and Safety Code Division 20, Chapter 6.95 §25533 and §25536.

In 1999, SNL, California had only one reportable acutely hazardous material,

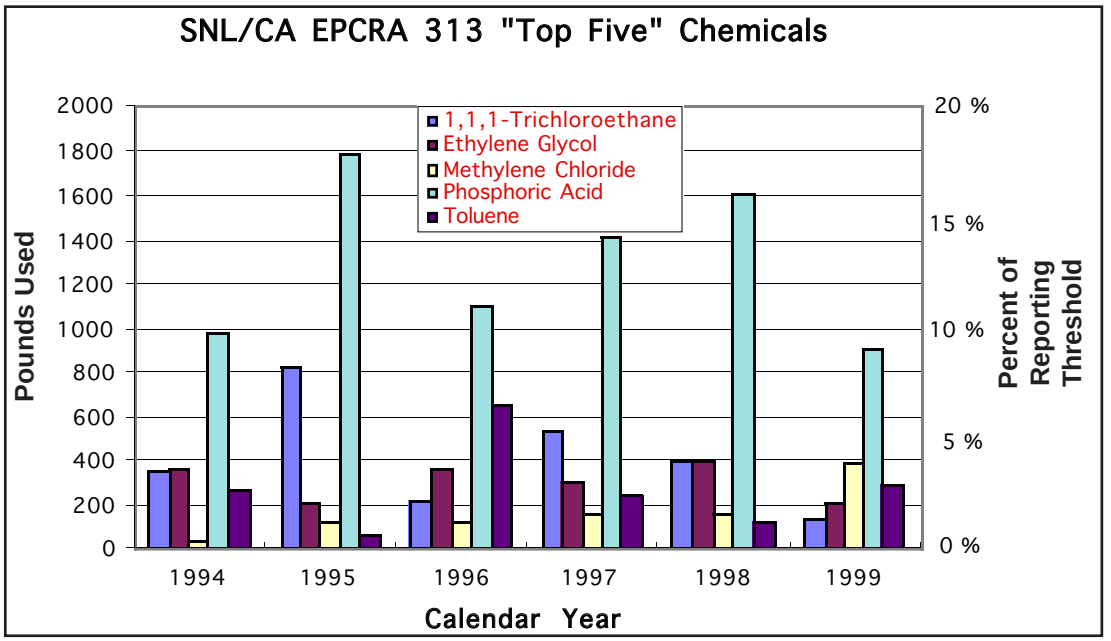


Figure 3-1. SNL, California EPCRA 313 "top five" chemicals.

sulfuric acid. This determination was based on the reporting threshold of 500 pounds.

Clean Water Act/Safe Drinking Water Act

Wastewater Discharge

The DOE/KAO and SNL, California maintains one Wastewater Discharge Permit issued by the City of Livermore. This permit regulates SNL, California's sanitary and industrial effluent, which is discharged to the City's sewer system, and enforces the requirements of the Federal Clean Water Act.

In 1999, all sanitary sewer effluent from the SNL, California site complied with the site outfall discharge limits for regulated physical parameters, metals, radionuclides, and EPA priority organic pollutants.

Details of all the wastewater monitoring and a summary of the sampling results are provided in the Sewer Outfall Monitoring section of Chapter 4, "Environmental Monitoring Program."

SNL, California operates one metal finishing categorical process subject to the EPA's pretreatment standards for point sources [Title 40 Code of Federal Regulations (CFR)], parts 403 and 433).[2,3] This process is the Printed Wiring Facility located in Building 910. The Printed Wiring Facility requires specific sampling of the wastewater it generates.

In 1999, all the liquid effluents from the Printed Wiring Facility process complied with pretreatment discharge standards (for metals and organic pollutants).

On March 24, 1999, SNL, California submitted a Baseline Monitoring Report to the LWRP to start up a semiconductor categorical process subject to the EPA's pretreatment standards for point sources (Title 40 CFR, parts 403 and 469.12).[2,4] The Livermore Water Reclamation Plant (LWRP) issued an amended 1998/1999 Wastewater Discharge Permit on May 3, 1999, to include monitoring requirements and discharge limits for the semiconductor manufacturing process. The categorical process came online in mid May 1999. This process is the Microstructures Laboratory located in Building 968, room 120. The Microstructures Laboratory requires specific sampling of the wastewater it generates. During the time peri-

od May to December 1999, all the liquid effluents from the Microstructures Laboratory process complied with pretreatment discharge standards (for arsenic, pH and organic pollutants).

National Pollutant Discharge Elimination System Storm Water General Permit for Industrial Activities

SNL, California is covered under the California Industrial Activities Storm Water National Pollutant Discharge Elimination System (NPDES) General Permit.[5] This permit allows SNL, California to comply with Federal permitting requirements for storm water discharges associated with industrial activities.

The permit requires SNL, California to implement a comprehensive storm water management program. SNL, California's program is designed to identify and eliminate non-storm water discharges to the storm drain system, implement a storm water pollution prevention plan, and establish a storm water monitoring plan. Although the State Water Resources Control Board administers the storm water general permit, the San Francisco Bay Regional Water Quality Control Board (Regional Board) enforces the general permit in Alameda County.

In response to Federal Clean Water Act permitting requirements for municipal storm water discharges, the City of Livermore and Alameda County Flood Control & Water Conservation District (Flood Control District) have adopted ordinances that control storm water discharges to the municipal storm drain system. However, under a Memorandum of Understanding with the Regional Board, the Regional Board is the lead regulatory agency for federal facilities such as SNL, California.

SNL, California's program ensures compliance with both the general permit and local agency storm water ordinances by implementing a Storm Water Pollution Prevention and Monitoring Plan[6] that strives to eliminate non-storm water discharges to the storm drains and minimizes the discharge of pollutants with storm water by implementing best management practices.

Drinking Water

The drinking water for the SNL, California site is supplied by the San Francisco Water District through the Hetch Hetchy Aqueduct. The San Francisco Water District is responsible for monitoring the quality of the incoming water. SNL, California neither treats nor samples the drinking water. LLNL maintains the drinking water distribution system for both sites. Maintenance includes water quality screening analyses.

Wastewater Discharge Permit

The DOE/KAO and SNL, California hold one Wastewater Discharge Permit issued by the LWRP. This permit regulates SNL, California's sanitary and industrial liquid effluent, which is discharged into the City's sewer system. It is renewed annually. It contains discharge limits for the site sanitary sewer outfall and for processes subject to EPA pretreatment standards. The permit also contains liquid effluent monitoring and reporting requirements. For more details, see Chapter 4, "Environmental Monitoring Program," which has a summary of the conditions of SNL, California's Wastewater Discharge Permit.

Groundwater Discharge Permit

In the past, the DOE/KAO and SNL, California held one Groundwater Discharge Permit issued by the LWRP. This permit regulated the discharge to the sanitary sewer system of water captured by the aquifer protection wells at the Fuel Oil Spill site. SNL, California treated the water before discharging it to the sanitary sewer system. The permit was renewed every two years. It contained discharge limits and monitoring and reporting requirements for the chemical constituents of concern. This permit was terminated by the Livermore

Water Reclamation Plant on August 19, 1999 based upon the Regional Board's approval to shut down operations at the Fuel Oil Spill site.

National Pollutant Discharge Elimination System Storm Water General Permit for Industrial Activities

SNL, California is covered under the California Industrial Activities Storm Water National Pollutant Discharge Elimination System (NPDES) General Permit.[5] This permit allows SNL, California to comply with Federal permitting requirements for storm water discharges associated with industrial activities.

More information on the Wastewater/Storm Water Monitoring Program may be found in Chapter 4, "Environmental Monitoring."

Clean Air Act/Air Quality Regulations

In 1999, SNL, California complied with applicable laws, regulations, and guidelines governing radiological and nonradiological emissions to the atmosphere.

Numerous operations at SNL, California are subject to the rules and regulations administered by the Bay Area Air Quality Management District (BAAQMD) because they emit, or have the potential to emit, air contaminants.[7] The BAAQMD and the California Air Resources Board are responsible for promulgating regulations and providing guidance to attain and maintain EPA and State of California air quality standards.

The BAAQMD Operating permit is renewed annually. In 1999, SNL, California had a BAAQMD permit for 24 sources of air pollutants, such as boilers, vapor degreasers, a paint spray booth, and various abatement devices (see Table 3-3). SNL, California also operated 29 exempt sources, such as, explosives test cell/facilities, abrasive blasters, plating operations, and Research and Development laboratories (see Table 3-4).

In 1999, SNL, California complied with all the conditions specified in its operating permits. Therefore, it received no violations for air emission exceedances.

Tables 3-3 and 3-4 list the type and number of permitted sources and exemptions granted to SNL, California.

NESHAPs Compliance for Radionuclides

The EPA regulates airborne emissions of radionuclides through the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAPs).[8] On December 15, 1989, the EPA revised its NESHAPs Rule for Radionuclides—Title 40 CFR, Part 61 (Subpart H applies to DOE facilities). It establishes radiation protection standards for protection of the public, monitoring requirements, and annual reporting of radionuclide air emissions. The EPA has established 10 mrem/yr as the allowable limit of radiation dose received by the public from air emissions. SNL, California is no longer required to perform emissions monitoring, or to perform annual dose calculations based on stack emissions. SNL, California performs dose calculations for individual projects with the potential to release radionuclides to the atmosphere.

No projects evaluated during 1999 had the potential to cause doses to the public at or near the EPA limits, or were at a level to cause a change to SNL, California's exemption from monitoring annual dose calculations.

National Environmental Policy Act Compliance

The National Environmental Policy Act (NEPA) is the basic national charter for the protection of the environment. NEPA requires all Federal agencies to consider issues associated with the physical and human environment in the review of proposed Federal actions. Frequently, the DOE prepares site-wide NEPA documents that consider ES&H issues associated with operation of a facility. For operations at SNL, California, a site-wide

environmental impact statement (EIS), the highest level NEPA document, was issued in August 1992 *(Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore,* DOE/EIS-0157). Although the effects of many new proposed projects, programs, and activities at Sandia are within the limits established in the EIS, DOE/KAO is required to evaluate each one for potential environmental effects.

Only DOE/KAO has the authority to make NEPA determinations for actions at SNL, California. Sandia assists the DOE with NEPA compliance by evaluating project effects, screening projects against valid NEPA determinations and documents, and preparing descriptions of proposed actions for DOE review. During 1999, 130 SNL, California projects were evaluated, and NEPA classifications and/or determinations made. Chapter 5, "Environmental Program Information," provides more information about SNL, California's NEPA activities in 1999.

More detail on the NEPA program may be found in Chapter 5, "Environmental Program Information."

Environmental Impact Statement

A site-wide EIS was issued for the SNL, California site in August 1992 *(Final Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore)*. At least every five years, DOE is required to evaluate the EIS and determine if a supplement analysis is required. Operations at SNL, California are included in the Supplement Analysis for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore (DOE/EIS-0157-SA-01).[9]

The Environmental Impact Statement (EIS) developed for SNL, California and LLNL contains a description of effluent monitoring at the two sites. Although no specific monitoring commitments are made in the EIS, the SNL, California effluent monitoring and environmental surveillance programs are accurately reflected by the description in the EIS.

Endangered Species Act

The Endangered Species Act of 1973 (ESA) is the federal law enacted to protect endangered and threatened species. In addition to this ESA, the State of California has promulgated an Endangered Species Act. Also, several other species are protected under the California Fish and Game Code. Table 3-5 lists the current status of sensitive species (i.e., endangered, threatened, Federal candidate, Federal species of concern, California fully protected, or California special concern species) either documented to reside in SNL, California or in the immediate vicinity.

Protection of Wetlands (Executive Order 11990)

During 1999, Sandia National Laboratories initiated activities to restore the embankment and streambed of the Arroyo Seco on the east side of the site. In accordance with 10 CFR 1022, *Compliance with Floodplain/Wetlands Environmental Review Requirements*, a floodplain and wetlands assessment was prepared. The assessment presented an evaluation of the potential effects to floodplain and wetland areas located at the project sites. Effects to wetlands from the proposed project included disturbance of approximate 2100 square feet of wetland and riparian vegetation. No effects to floodplains were identified.

To mitigate disturbance to wetland areas, the wetland area was replanted in December 1999. Plugs of native wetland plants were collected from with Arroyo Seco and replanted in the disturbed area. Additionally, the bank of the Arroyo was reseeded with native grass mixture.

Other Environmental Statutes

In 1999, SNL, California had no significant activities governed by the following regulations:

- Toxic Substances Control Act,
- Federal Insecticide, Fungicide, and Rodenticide Act,
- National Historic Preservation Act.

SNL, California maintains compliance with the regulations listed above through internally generated procedures and review of DOE orders. No lawsuits pertaining to any environmental regulation are on file against SNL, California.

OTHER ISSUES AND ACTIONS

Audits and Inspections

Operations at SNL, California are routinely subjected to internal inspections as part of a self-assessment program. In addition to this internal scrutiny, external regulatory agencies audited or inspected SNL, California in 1999. Table 3-6 lists these audits and inspections by date. The table also cites the purpose and the regulatory agency performing the inspection or audit.

Occurrence Reports

DOE O 232.1A, Occurrence Reporting and Processing of Operations Information,[10] requires that occurrences be consistently reported to assure that both the DOE and SNL management are kept informed of all events that could:

- affect the health and safety of the public;
- seriously impact the intended purpose of DOE facilities;
- have a noticeable adverse effect on the environment; or
- endanger the health or safety of workers.

The SNL, California Occurrence Reporting System has established a formal process for investigating and notifying the DOE of unusual events at the site. The goals of SNL, California's Occurrence Reporting System are to ensure the following:

- timely identification, categorization, notification, and reporting to SNL and DOE management;
- timely evaluation and implementation of corrective actions, including root cause analyses to identify appropriate corrective actions; and
- dissemination of lessons learned to prevent occurrence of similar events.

There were no environment-related occurrences at Sandia National Laboratories, California during 1999.

STREAMBED ALTERATION AGREEMENT

SNL, California has a Streambed Alteration Agreement with the California Department of Fish and Game to conduct maintenance activities in the Arroyo Seco. The Streambed Alteration Agreement allows Maintenance personnel to remove debris that accumulates in the Arroyo using hand held equipment only. These activities are necessary to reduce the potential for flooding during rain events. The authorization is valid for three years.

SNL, California also has a Streambed Alteration Agreement with the California Department of Fish and Game for the initial phase of work to restore the streambed and repair the embankment at the east buffer trash rack. The initial phase involved removing sediment and debris from behind the trash rack located in Arroyo Seco. Because the project location is within the wetland and riparian corridor in the eastern portion of the Arroyo, wetland restoration was required. Debris removal was completed in late October 1999, and wetland restoration was initiated in December 1999. An area of approximately 1000 square feet was restored by planting plugs of native wetland plants, willow cuttings, and a native grass seed mixture. The area will be monitored for growth over the next three

years to ensure that restoration efforts are successful.

REFERENCES

1. State of California, Environmental Protection Agency, RCRA *Facility Assessment Report* (March 1992).

2. U.S. EPA, Title 40 CFR, Part 403, *Federal Wastewater Pretreatment Standards* (July 1994).

3. U.S. EPA, Title 40 CFR, Part 433, *Metal Finishing Point Source Category* (July 1994).

4. U.S. EPA, Title 40 CFR, Part 469, Semiconductor Point Source Category (July 1994)

5. State of California, "NPDES General Permit for Storm Water Discharge Associated with Industrial Activities," State Water Resources Control Board (September 17, 1992)

6. EOA, Inc., Storm Water Pollution Prevention and Monitoring Plan, for Sandia National Laboratories/California (August 1999).

7. State of California, Bay Area Air Quality Management District, Rules and Regulations (issued January 1980; as revised).

8. U.S. EPA, Title 40 CFR, Part 61, NESHAPs (December 15, 1989).

9. *Supplement Analysis for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore* (DOE/EIS-0157-SA-01).

10. U.S. DOE, O 232.1, Occurrence Reporting and Processing of Operations Information (July 21, 1997).

Table 3-1. Major Environmental Regulations Applicable to SNL, California.

Legislation	Description
Resource Conservation and Recovery Act **(RCRA)**	RCRA regulates hazardous, nonhazardous, and medical waste. It also regulates underground storage tanks containing hazardous substances and petroleum products.
Comprehensive Environmental Response, Compensation, and Liability Act **(CERCLA)** Superfund Amendments and Reauthorization Act **(SARA)**	CERCLA and SARA establish liability, compensation, cleanup, and emergency response for hazardous substances released to the environment.
Emergency Planning and Community Right-to-Know Act **(EPCRA)**	EPCRA (SARA Title III) requires that hazardous substances used on site be reported to State and local governments and to the general public.
Clean Water Act **(CWA)** National Pollutant Discharge Elimination System **(NPDES)**	Through the NPDES, the CWA regulates liquid discharges for both wastewater and storm water discharges from industrial activities.
Clean Air Act **(CAA)** National Emission Standards for Hazardous Air Pollutants **(NESHAPs)**	The CAA and NESHAPs set air quality standards for hazardous air emissions, such as radionuclides and benzene.
Toxic Substances Control Act **(TSCA)**	The TSCA controls the use and exposure of new industrial chemicals. It also regulates the use and disposal of polychlorinated biphenyls (PCBs).
National Environmental Policy Act **(NEPA)**	NEPA establishes criteria for evaluating potential environmental impacts of Federal activities and alternatives.
Migratory Bird Teaty Act **(MBTA)**	The MBTA prohibits the take, killing, or possession of any migratory bird, part, nest, or egg.
California Fish and Game Code	The Fish and Game Code provides protections for many species of plants and animals.
City of Livermore Municipal Code	The code defines pollutant discharge limits for sanitary sewer effluents.

Table 3-1. Major Environmental Regulations Applicable to SNL, California. (continued)

Legislation	Description
State Water Resources Control Board Water - Quality Order No. 97-03-DWQ	This order contains the provisions for monitoring storm water runoff.
Title 22 - California Code of Regulations	Title 22, Division 4.5 covers the State hazardous waste management system.
California Health and Safety Code	This code covers hazardous materials and community right-to-know issues.
Endangered Species Act **(ESA)**	The ESA prohibits Federal Agencies from taking any action that would jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat.

Table 3-2. SNL, California Environmental Permits in 1999.

Category	Regulation/Authority	Permit Status
Waste Management	Title 40 CFR 264 (RCRA), EPA; Title 22 CCR, Division 4.5, Cal/EPA	Part B permit effective until January 4, 2003.
Air Quality	Bay Area Air Quality Management District	Bay Area Air Quality Management District Permit-to-Operate for 53 emission sources. Permit renewed annually. (See Tables 3-3 and 3-4).
Wastewater Discharge	City Ordinance, City of Livermore	Permit for the site sanitary and industrial wastewater discharge. Permit renewed annually.
Storm Water Discharge	Clean Water Act (Title 40 CFR 122–124), EPA National Pollutant Discharge Elimination System, State Water Resources Control Board	SNL, California has a Notice of Intent on file with the State Water Resources Control Board. As a result, Sandia is covered by the State's National Pollutant Elimination System, General Permit for Discharge of Storm Water Associated with Industrial Activities. Permit renewed every 5 years.
Groundwater Discharge	City Ordinance, City of Livermore	Permit for discharging treated groundwater to the sanitary sewer. Permit renewed every 2 years. Permit terminated August 19, 1999.
Streambed Alteration Agreement #1226-97	Sections 1601–1606 Fish and Game Code/California Department of Fish and Game	Authorization to remove debris with hand-held equipment only. Effective until October 2000.
Streambed Alteration Agreement #0996-99	Sections 1601-1606 Fish and Game Code/California Department of Fish and Game	Authorization for initial phase of work to restore the stream bed and repair of embankments at the East buffer trash rack. The initial phase removed built up sediment and debris from the trash rack. Effective until December 2000.

Table 3-3. SNL, California Bay Area Quality Management District Permitted Sources.

Source Type	Number of Permits Held
Boilers	12
Degreasers/cleaners	3
Paint spray booth	1
Gasoline dispensing facility	1
Miscellaneous	7
Total	24

Table 3-4. Bay Area Quality Management District Exemptions Held by SNL, California in 1999.

Source Type	Number of Exemptions Held
Research and Development Laboratories	13
Diesel fuel dispensing tanks	2
Explosive test cells	3
Abrasive blasters	2
Miscellaneous	9
Total	29

Table 3-5. Sensitive Species Found in the Vicinity of SNL, California.

Species	Found On-Site	Federal Status[b]	State Status[a]
Reptiles and Amphibians			
California Tiger Salamander *(Ambystoma tigrinum)*	Y	Candidate for listing	Fully protected
California Red-legged Frog *(Rana aurora draytonii)*	N[a]	Threatened	Fully protected
Alameda Whipsnake *(Masticophis lateralis euryxanthus)*	N[a]	Threatened	Threatened
Birds			
Western Burrowing Owl *(Athene cunicularia)*	Y	Species of concern	Species of special concern
Loggerhead Shrike *(Lanius ludovicanus)*	Y	Species of concern	Species of special concern
White-tailed Kite *(Elanus leucurus)*	Y	Not listed	Fully protected
Golden Eagle *(Aquila chrysaetos)*	Y	Not listed	Species of special concern
Northern Harrier *(Circus cyaneus)*	Y	Not listed	Species of special concern
Mammals			
San Joaquin Kit Fox *(Vulpes macrotis mutica)*	N[a]	Endangered	Threatened

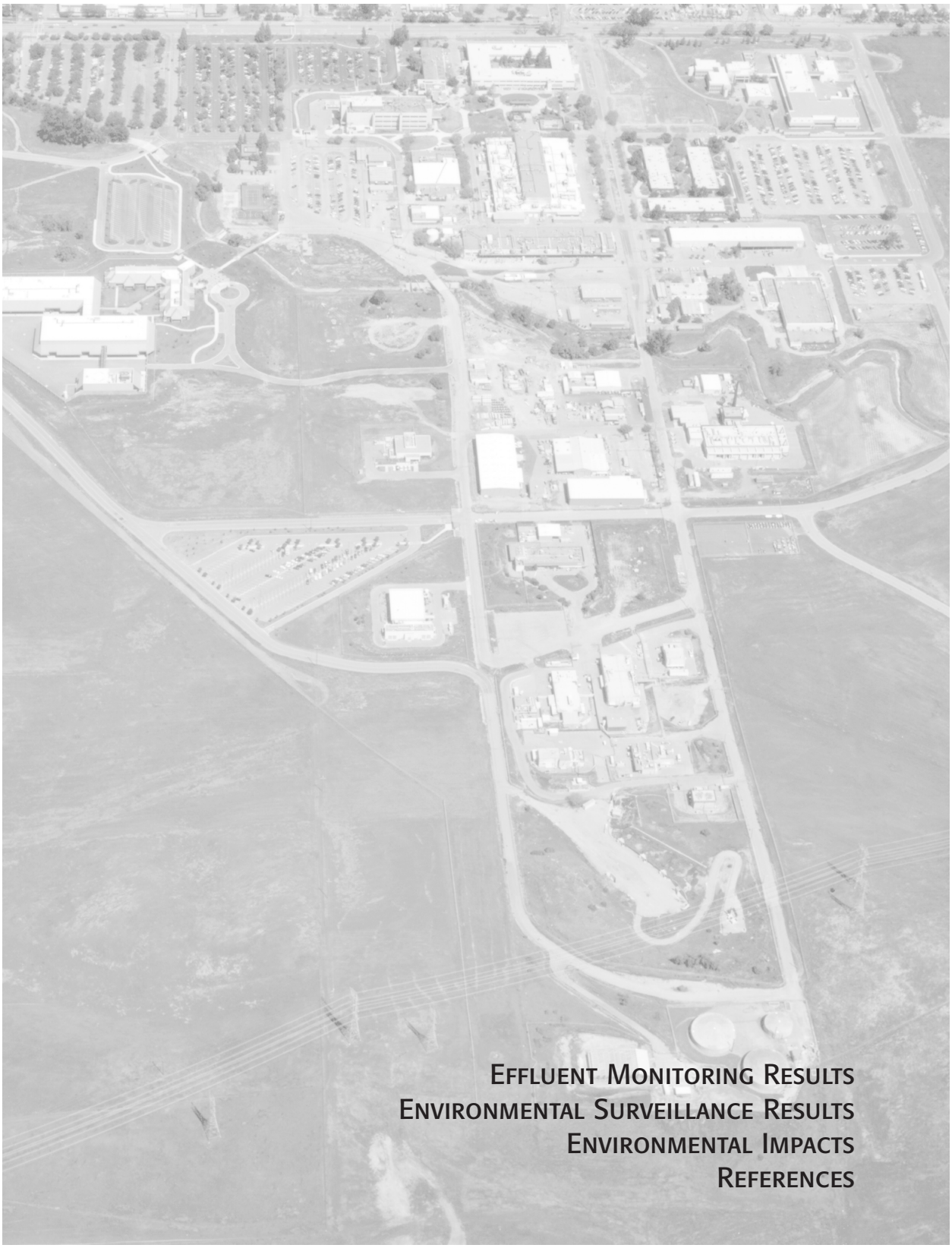
[a]Known to be present in the vicinity, but not seen at SNL, California.

[b]Some species are protected by more than one law or regulation. Only the most commonly used is listed here.

Table 3-6. Environmental Audits and Inspections of SNL, California in 1999.

Date	Regulatory Authority	Purpose
8/30 & 9/15–16/99	Calif. Department of Toxic Substance Control	Inspection of permitted facility and two permit-by-rule operations.
12/6–7/99	City of Livermore Water Reclamation Plant	Wastewater inspection

4 — Environmental Monitoring Program



Effluent Monitoring Results
Environmental Surveillance Results
Environmental Impacts
References

The Environmental Operations Department at Sandia National Laboratories (SNL), California—in conjunction with Lawrence Livermore National Laboratory (LLNL)—maintains effluent monitoring and environmental surveillance programs. The purpose of these programs is to assess and control potential impacts, if any, to the public and the environment from operations at SNL, California. The department monitors effluents, as required making sure SNL, California continually complies with environmental protection laws and standards. Monitoring activities verify the effectiveness of emission control measures by routinely examining environmental media, such as groundwater, storm water runoff, and sewage, for radionuclides (if appropriate), and hazardous chemicals that may be emitted from site operations. An extensive environmental dosimeter network also measures external radiation levels.

SNL, California's environmental monitoring activities (jointly with LLNL) ensure that all significant exposure pathways are monitored. Table 4-1 shows the types and number of samples collected, the collection frequency, and the parameters measured.

This chapter discusses the results of SNL, California and LLNL's joint monitoring and surveillance activities. The data are interpreted and evaluated according to applicable standards.

EFFLUENT MONITORING RESULTS

Airborne Effluents

The Bay Area Air Quality Management District regulates air emissions of nonradiological pollutants by issuing operating permits. These permits set operating conditions or limitations on sources (equipment or operations) that may emit pollutants to the air. SNL, California has no sources that require routine emission monitoring for pollutants. SNL, California's permits are discussed further in Chapter 3, Compliance Summary.

Liquid Effluents

SNL, California's Wastewater/Storm Water Program ensures that liquid effluents generated by SNL, California operations comply with applicable regulations. Wastewater discharge limits are imposed by the Department of Energy (DOE),[1] the City of Livermore, and other State and Federal agencies. Frequency, methods of sample collection, and parameters for which to analyze are specified in Federal regulations or by SNL, California's wastewater discharge permit. SNL, California continually strives to reduce pollutants in liquid effluents to the lowest levels possible.

In 1982, the Environment Protection Agency (EPA) National Pretreatment Program provisions of the Clean Water Act (CWA) established liquid effluent monitoring requirements for specific pollutants.[2] Accordingly, SNL, California's Wastewater Control Program emphasizes controlling effluents at the source. SNL, California imposes strict administrative and engineering controls to prevent contaminated liquid discharge to the sanitary sewer system.

Wastewater from SNL, California operations is collected and analyzed before it is released to the sanitary sewer. This analysis allows SNL, California personnel to verify that contaminant levels are acceptable before they allow the water to be released to the sanitary sewer. Almost always, the contaminant concentrations are less than the discharge limits and often are less than detection limits. SNL, California is able to treat wastewater with contaminant concentrations greater than internal site limits, but less than hazardous waste limits. This capability allows SNL, California to further reduce the already low risk of contaminants entering the sanitary sewer. In addition to monitoring at the source, SNL, California extensively monitors the sani-

tary sewer effluent as it leaves the site (see Sewer Outfall Monitoring below).

Liquid effluent discharges are analyzed according to applicable regulations governing discharges to a publicly owned treatment works. These regulations include:

- Federal Regulations
  The CWA provides the legislative framework for protecting the nation's waterways. Liquid discharges into surface waters and municipal sewer systems from industrial sources are regulated. In accordance with the objectives of the CWA, the Environmental Protection Agency (EPA) has established categorical pretreatment standards for specified classes of industrial dischargers. SNL, California is designated as a "Metal Finishing Point Source Category" and a "Semi-conductor Point Source Category." Therefore, SNL, California is subject to the pretreatment standards in Title 40 Code of Federal Regulation (CFR), Parts 403, 433, and 469.12. These standards are based on available pollution control technology for specific industrial processes.
- State of California
  The EPA has delegated authority to the State of California to enforce the National Pollutant Discharge Elimination System (NPDES) and Federal Categorical Pretreatment Standards (Title 40 CFR, Part 403).[2] The San Francisco Bay Regional Water Quality Control Board has issued an NPDES permit to the City of Livermore Water Reclamation Plant (LWRP). In addition, the Federal pretreatment program is administered through the LWRP with oversight by the San Francisco Bay Regional Water Quality Control Board. This arrangement ensures a viable pretreatment program and enforcement of all pertinent State and Federal regulations.
- City of Livermore
  Section 13.32 of the City of Livermore Municipal Code contains the discharge limits for the city of Livermore's sanitary sewer system. These limits are stated in Sandia's Wastewater Discharge Permit, issued annually by the LWRP.

  In general, no facility may discharge any pollutant or wastewater that will interfere with the operation or performance of the publicly owned treatment works.
- DOE Orders
  The principal DOE order governing discharges to public sewer systems is DOE Order 5400.5, Radiation Protection of the Public and the Environment. The purpose of this order is to establish standards and requirements for DOE operations to protect members of the public and the environment against undue risk from radiation. The DOE orders only address radiation protection, e.g., radionuclide discharges to public sewer systems.

  No radionuclides are routinely discharged to the sanitary sewer from operations at the SNL, California site.

Liquid Effluent Control Systems Description

SNL, California controls at the generating source potentially contaminated liquid effluents from the major wastewater generating operations on-site. These effluents are routed to liquid effluent control systems (LECS). LECS consist of large, monitored holding tanks, which collect wastewater, allowing it to be analyzed before being released to the sanitary sewer. By retaining the wastewater at the point of generation, SNL, California can attempt to ensure it is within allowable limits before discharging it and can prevent most accidental releases to the sanitary sewer system.

LECS Locations

Figure 4-1 shows the locations of all the LECS at the SNL, California site:

- Building 968—all floor drains and laboratory sinks in Building 968 are routed to a LECS consisting of two 2,500-gallon tanks.
- Building 913—process wastewater from the central and southern portions of Building 913 and from laboratories in Building 916 is routed to a LECS consisting of three 5,000-gallon tanks.
- Building 910—process wastewater is routed from the Printed Wiring Laboratory to a LECS consisting of one 5,000-gallon tank.
- Building 961—water from decontamination operations is routed to a LECS consisting of one 2,000-gallon tank.
- Building 906-process wastewater is routed to a LECS consisting of two 5,000-gallon tanks.
- Building 941—process wastewater is routed to a LECS consisting of two 5,000-gallon tanks.

Methods

To assure that a representative sample is collected, the contents of the tanks are agitated by recirculation or air bubbling before they are sampled.

Analyses

To ensure compliance with the SNL, California wastewater permit requirements, a grab sample of the LECS contents is collected before the water is discharged to the sanitary sewer. A State-certified commercial laboratory analyzes the samples for parameters associated with the process generating the wastewater. The analyses typically include arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc. If needed, analyses for uranium and tritium maybe performed by SNL, California personnel.

Federal Categorical Processes

Locations

SNL, California operates one metal finishing categorical process subject to the EPA's pretreatment standards for point sources (Title 40 CFR, parts 403 and

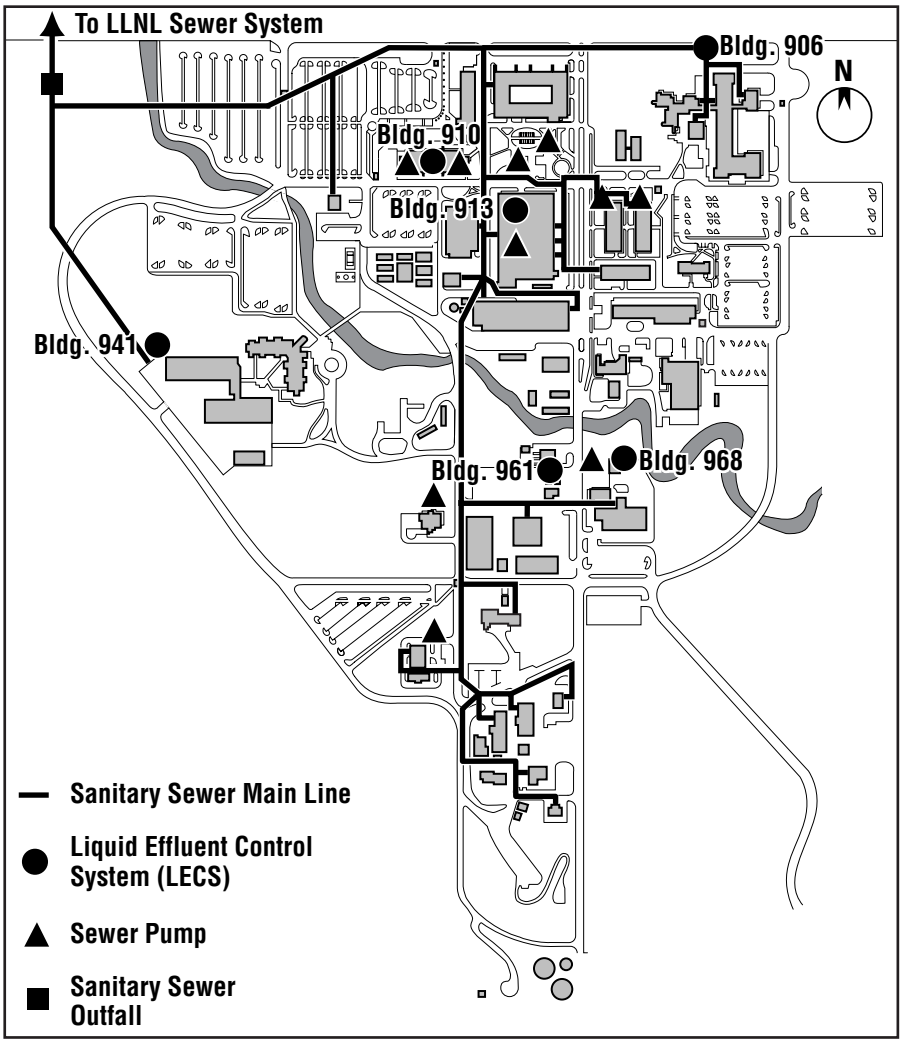


Figure 4-1. Sewer and LECS locations.

433).[2,3] This process is the Printed Wiring Facility located in Building 910.

On March 24, 1999 SNL, California submitted a Baseline Monitoring Report to the LWRP to start up a semiconductor categorical process subject to the EPA's pretreatment standards for point sources (Title 40 CFR, parts 403 and 469.12) [2,4]. The LWRP issued an amended 1998/1999 Wastewater Discharge Permit on May 3, 1999, to include monitoring requirements and discharge limits for the semiconductor manufacturing process. The categorical process came on line in mid May 1999. This process is the Microstructures Laboratory located in Building 968, room 120.

Semiannually, SNL, California conducts special sampling procedures for these facilities' wastewater. The compliance point for categorical processes is at the end of the process, not at the site outfall. The discharge limits for these processes differ from those imposed on SNL, California's site outfall (see below).

Analyses

To comply with the requirements of the Federal Pretreatment Standards and the LWRP wastewater permit, SNL, California collects grab samples of the wastewater from the Printed Wiring Laboratory semiannually. A State-certified commercial laboratory analyzes the samples for pH, arsenic, cyanide, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, and toxic organic compounds. The toxic organic compound analysis covers all EPA priority organic pollutants.

To comply with the requirements of the Federal Pretreatment Standards and the City of Livermore Wastewater Treatment Plant wastewater permit, SNL, California collected grab samples of the wastewater from the Microstructures Laboratory monthly during the first six months of operation, and quarterly during the next six months of operation. After the initial year of operation, sampling will be conducted semiannually. A State-certified commercial laboratory analyzes the samples for pH, arsenic and organic pollutants.

Results

The 1999 data for the semiannual monitoring for the Printed Wiring Laboratory showed that the wastewater met all of the pretreatment standards. The following parameters were consistently seen above their detection limits, but below their regulatory limits:

- Chromium—the regulatory limit for chromium is 1.71 mg/L. Chromium was seen at levels ranging from 0.01 to 0.49 mg/L.
- Copper—the regulatory limit for copper is 2.07 mg/L. Copper was seen at levels ranging from 0.06 to 1.7 mg/L.
- Zinc—the regulatory limit for zinc is 1.48 mg/L. Zinc was seen at levels ranging from 0.01 to 0.97 mg/L.

The data from May to December 1999 for the monthly monitoring for the Microstructures Laboratory showed that the wastewater met all of the pretreatment standards. The total toxic organic (TTO) parameters was seen above the detection limit, but below the regulatory limit:

- TTO—the regulatory limit for TTO is 1.37 mg/L. TTO was seen at levels ranging from 0.085 to 0.950 µg/L.

These data are also reported in the SNL, California *Categorical Process Report*, which is submitted to the LWRP semiannually.[4]

For more details on analytical results, see Appendix A, Table A-1.

Groundwater Discharge to the Sanitary Sewer

Location

SNL, California operated a network of aquifer protection wells and a system of injection and withdrawal wells. The purpose of the groundwater extraction network was to capture any groundwater contaminated by the diesel fuel at the Fuel Oil Spill site.

Treatment water from the in situ bioremediation activities was captured from the soils by the withdrawal wells and was passed through an above ground treatment system.

Effluent from the treatment system was discharged to the sanitary sewer system and was subject to the discharge limits and monitoring and reporting requirements of the Groundwater Discharge Permit issued by the LWRP. SNL, California's Groundwater Discharge Permit was renewed in July 1999. To comply with the Groundwater Discharge Permit, SNL, California collected grab samples of effluent from the treatment system quarterly. SNL, California's Groundwater Discharge permit was terminated by the LWRP on August 19, 1999 based upon the Regional Water Quality Control Board (RWQCB) approval to shut down operations at the Fuel Oil Spill site.

Analyses

On January 27, 1997 the City of Livermore issued an amendment to the Groundwater Discharge permit. Previously, the Groundwater Discharge permit required samples to be analyzed for total petroleum hydrocarbons-diesel (TPH-Diesel) and benzene, toluene, ethylbenzene, xylene (BTEX). The amendment eliminated the sampling requirement for BTEX. Samples collected after January 1997 were analyzed for TPH-Diesel only. A State-certified commercial laboratory analyzes the samples for total petroleum hydrocarbons as diesel.

Results

Groundwater discharge to the sanitary sewer in 1999 complied with the discharge permit requirement. All of the results were below the detection limit. The permit limit is 250 µg/L for TPH-Diesel.

Details of the Environmental Restoration Program, which the fuel oil spill site is a part of, are provided in Chapter 6, "Groundwater."

Sewer Outfall Monitoring

SNL, California monitors its sanitary sewer effluent before it exits the site and joins the sanitary sewer flow from LLNL. Monitoring is continuous and sampling comprises grab and flow-proportional daily and weekly composite sampling.

Locations

Samples are collected at the monitoring station at the site sewer outfall. Figure 4-1 shows the site's sanitary sewer system and the location of the sanitary sewer monitoring station at the SNL, California site.

Methods

SNL, California uses real-time instruments to continuously monitor the site sewer effluent for flow and pH. Grab samples are taken from the effluent stream immediately after it reaches the real-time monitors. Flow-proportional samples are collected by two automatic, refrigerated, ISCO in-line samplers, one collecting a daily composite sample and the other a weekly composite. The daily composite sample is retained as an archive sample to use if confirmatory analyses are required.

Analyses

A flow-proportional composite sampler samples the sewer effluent so that SNL, California can monitor its compliance with the discharge limits contained in the site's Wastewater Discharge Permit. SNL, California conducts all sampling and analysis in accordance with the provisions of the permit.

SNL, California continuously monitors the liquid effluent at the site sewer outfall for pH and flow. SNL, California collects composite and grab samples and sends them to a State-certified laboratory for analysis.

The weekly composite sample is analyzed for metals. Monthly, a composite sample is analyzed for total dissolved solids (TDS), total suspended solids (TSS), biochemical oxygen (BOD), chemical oxygen demand (COD), and specific

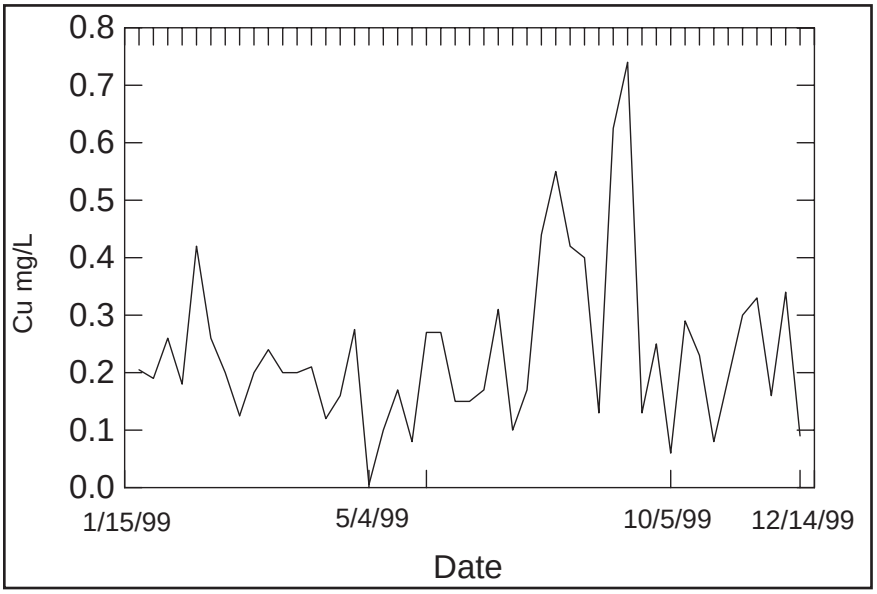


Figure 4-2. Copper concentrations in the sanitary sewer.

conductivity. A grab sample is collected monthly and is analyzed for cyanide, oil and grease, tributyl tin and EPA priority organic pollutants (EPA Methods 624 and 625). Beginning May 1999 the requirement to sample for oil and grease is suspended until such time as the Livermore Municipal code can be modified to remove the references to "freon extractable" oil and grease. Many laboratories are changing the EPA methods implemented to switch from freon to hexane. After the code is modified the requirement to analyze for oil and grease will be added back into the permit. All the analytical results are tabulated in SNL, California's Wastewater Discharge Compliance Report, which is submitted to the LWRP monthly.[5]

Quality Assurance

SNL, California retains the daily composite sample as an archive sample. This archive sample is analyzed in case the weekly composite sample shows a concentration greater than or equal to fifty percent of the discharge limit of any of the regulated metals. Data from the archive sample analysis are used to validate data from the weekly sample. SNL, California collects duplicate samples monthly for all parameters.

Results

In 1999, all liquid effluent from the SNL, California sanitary sewer outfall complied with the site outfall discharge limits for regulated physical parameters, metals, and EPA-priority organic pollutants.

The following parameters were consistently seen above their detection limits, but below their regulatory limits:

- Copper—the regulatory limit for copper is 1.0 mg/L. Copper was seen at levels ranging from <0.005 to 0.74 mg/L. Figure 4-2 shows weekly composite copper concentrations in the sanitary sewer for 1999.
- Lead—the regulatory limit for lead is 0.20 mg/L. Lead was seen at levels ranging from <0.005 to 0.07 mg/L
- Zinc—the regulatory limit for zinc is 3.0 mg/L. Zinc was seen at levels ranging from 0.09 to 2.0 mg/L.

SNL, California performed a Mann-Kendall trend test on the 1999 metals and physical data. No parameters showed upward trends. Specific conductance showed a downward trend. Cadmium and Nickel also showed downward trends, but a large percentage of the samples were below the detection limit for these metals. All other parameters showed no detectable trend.

For more details on analytical results, see Appendix A, Table A-2.

Storm Water Runoff

Description

As storm water flows off buildings, material-handling areas, parking lots, and other impervious areas on-site, it may pick up various pollutants, such as oil and grease,

soil, litter, pesticides, and fertilizer. During dry weather, any non-storm-water discharge eventually evaporates; however, pollutants left on the ground still may be picked up and transported by runoff in a subsequent rainstorm. The SNL, California storm drain system conveys all runoff to the Arroyo Seco, which discharges into the Alameda Creek and eventually to the San Francisco Bay.

To assess the impact of site operations to storm water discharge, SNL, California collects samples of surface runoff at various points in the site's storm drain system.

Locations

Figure 4-3 shows the storm water sampling locations at SNL, California, as follows:

- Location A—maintenance, materials handling and storage, and equipment storage on the west side of the Combustion Research Facility.
- Location B—material handling and equipment transfer for a maintenance area.
- Location C—handling of all incoming materials on site.
- Location D—material handling and storage; hazardous materials storage area; maintenance yard.
- Location F—material handling area and storage sheds.
- Location G—material handling area and storage sheds; chemical storage shed and loading dock.
- Location N—inactive Navy Landfill area now used for storing explosive materials in bunkers. This location is an upstream discharge location to the Arroyo Seco. Runoff from the old Navy Landfill area is monitored to evaluate the potential for erosion.
- Location X—maintenance and equipment storage areas in the vicinity of building 968.
- Location Y—Arroyo Seco entering the site.
- Location Z—Arroyo Seco exiting the site.

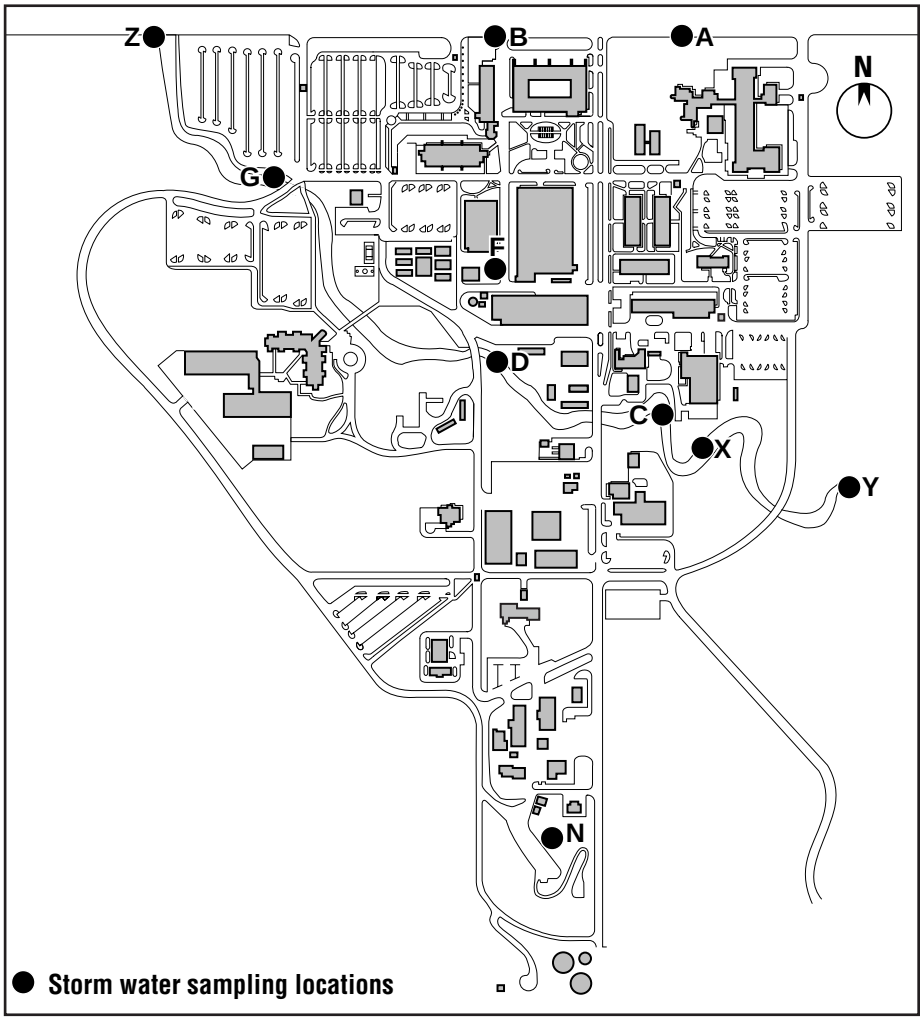


Figure 4-3. Storm water sampling locations on the SNL, California site.

Methods

SNL, California collects samples during two storms that produce runoff sufficient to allow collection of storm water in sample bottles. The difference of the ground's permeability in different areas throughout the site often means there is surface runoff in some areas and none in other areas during the same storm event. SNL, California continues to sample until there are two samples for each location if possible; therefore, there are usually more than two storm events sampled throughout the year.

Samples are collected at points in the storm water conveyance system that best represent certain drainage areas and types of activities. Storm water samples are collected and preserved in accordance with EPA standard methods, which are described in Title 40 CFR, Part 136.[6]

Storm water sampling is conducted during the wet season. The two wet seasons in 1999 occurred between October 1998-May 1999 and October 1999-May 2000. In 1999, ten locations were sampled for the 1998-1999 wet season and four locations were sampled for the 1999-2000 wet season. SNL, California will collect the second round of sampling for the remaining six locations in 2000.

Automatic samplers are installed at locations D, G, Y, and Z that represent the sampling locations in the Arroyo Seco. As slope conditions do not allow safe access to the arroyo during storm events, automatic samplers help ensure the safety of SNL, California personnel during storm water sampling.

Analyses

A State-certified laboratory analyzes storm water samples for specific conductivity, pH, total suspended solids, and oil and grease, as required by SNL, California's storm water permit requirements. Ammonia, arsenic, cadmium, cyanide, chemical oxygen demand, nitrate/nitrite, aluminum, iron, lead, magnesium, mercury, selenium, silver and zinc were added to the SNL, California sampling suite when the general permit was reissued in April 1997. The additional parameters were incorporated into the 1998/99 and 1999/2000 wet seasons sampling. SNL, California also performed tritium analyses for baseline information.

Quality Assurance

SNL, California collects approximately 10% duplicate samples and field blank samples to assess potential contamination of storm water samples. Duplicate and blank sample collection locations are randomly chosen and vary between storms.

Results

Regulatory agencies have not established numerical effluent standards for storm water discharge. SNL, California uses sampling data to optimize storm water pollution prevention activities and to identify trends. The 1993 through 1999 data will provide a baseline to which future samples will be compared.

SNL, California's 1999 storm water sampling results successfully identified site conditions and activities that impacted storm water quality. No pollutants were detected at levels that would be a cause for concern during 1999. A critical review of the results shows the following:

- Oil and Grease—Oil and grease were detected at 1.0, 1.6, 2.2, and 17 mg/L at locations Z, A, C, F, respectively, during the November 1999 sampling event. This is the second time oil and grease has been detected above detection limit and SNL, California is reviewing pollution prevention practices in these drainage areas.
- pH—Sample pH ranged from 6.9 to 9.0. Two locations (F and Y) had pH concentrations above the range of the guidance published by the State Water Resources Control Board (State Board). SNL, California is

reviewing pollution prevention practices in these drainage areas. Figure 4-4 shows pH levels in storm water runoff.

- Total suspended solids (TSS)—TSS concentrations ranged from below the detection limit of 10 mg/L to 230 mg/L. The concentrations detected are within the range of those seen in previous years. Figure 4-5 shows concentrations of TSS in storm water.
- Specific conductivity—Specific conductivity measurements ranged from 31 to 2000 µmhos/cm. The highest value is from location Y, which represents background storm water as it flows onto SNL, California activities have no impact on runoff collected from location Y. The highest specific conductivity concentration from a sampling location on site was 100 µmhos/cm. Figure 4-6 shows specific conductivity levels in storm water.
- Aluminum—Detectable aluminum concentrations ranged from 0.33 to 5.7 mg/L. Concentrations are similar to those detected in 1998.
- Iron—Iron concentrations ranged from 0.08 to 7.3 mg/L. The concentrations detected are within the range of those seen in 1998.
- Nitrate and Nitrite Nitrogen—Nitrate and nitrite nitrogen concentrations ranged from below the detection limit of 0.1 to 0.22 mg/L. On site concentrations are similar to those detected in 1998.
- Zinc—Zinc concentrations ranged from 0.02 to 4.7 mg/L. The concentrations detected are within the range of those seen in previous years when certain metals were analyzed for baseline information.
- Magnesium—Magnesium concentrations ranged from 0.5 to 89 mg/L. The sample with the highest concentration was collected at location Y, which represents storm water as it flows on site. The highest concentration from a sampling location in the site is 3.5 mg/L. On site concentrations are similar to those detected in 1998.

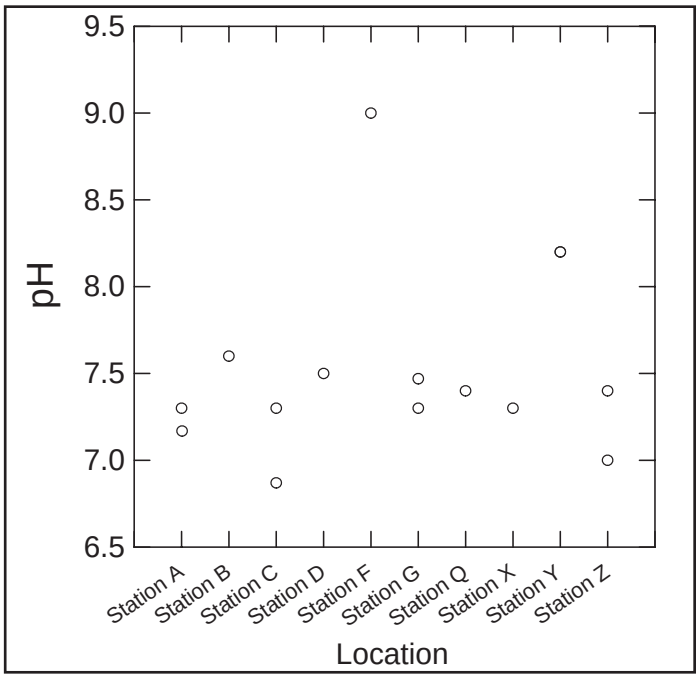


Figure 4-4. pH in storm water.

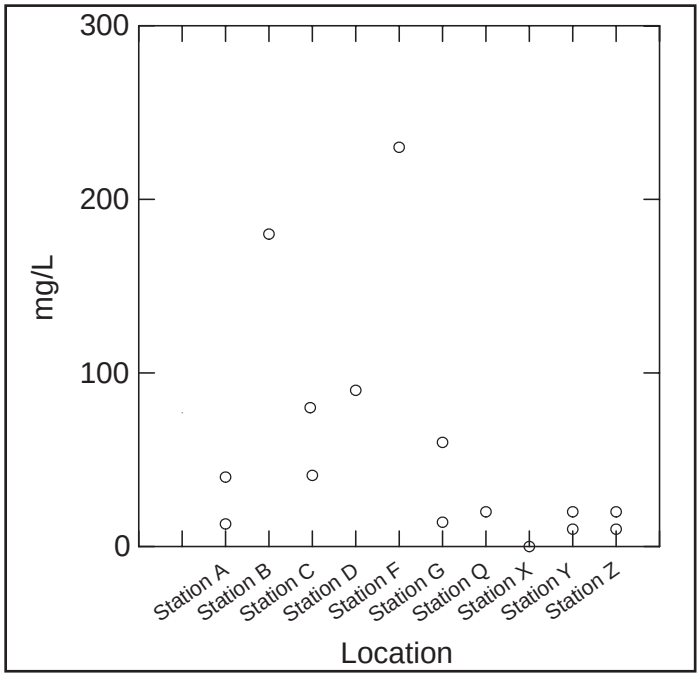


Figure 4-5. Total suspended solids in storm water.

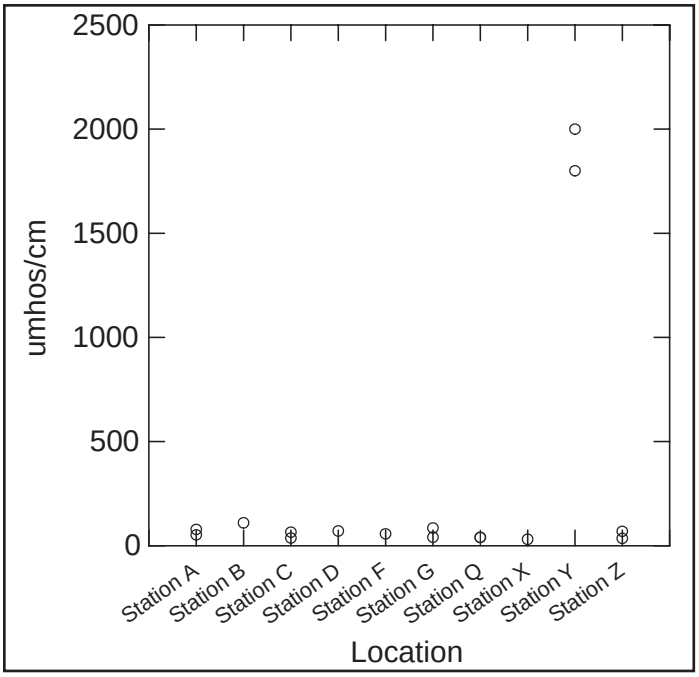


Figure 4-6. Specific conductivity in storm water.

- Selenium—As in 1998, selenium concentrations were all below the detection limit of 0.07 mg/L.
- Ammonia-N—Ammonia-N concentrations ranged from less than 0.05 to 0.06 mg/L, well below 1998 concentrations.
- Chemical Oxygen Demand (COD)—COD concentrations ranged from 8 to 27 mg/L. Concentrations are similar to those detected in 1998.
- Cyanide—Cyanide concentrations were all below the detection limit of 0.01 mg/L. Concentrations are similar to those detected in 1998.
- Additional metals—In 1999, arsenic, cadmium, lead, mercury, and silver were also analyzed. Concentrations were not detectable.

A Mann-Kendall test for trend was applied to the storm water data for the first time during 1999. All data collected since the implementation of the storm water sampling program were included in the trend test in order to have enough data for the statistical analysis to be run.

The results of the trend tests are as follows:

- Zinc: Upward trend at Station A.
- Ammonia-N: Downward trend at Station A, upward trend at Station B, upward trend at Station D, upward trend at Station F, downward trend at Station G, downward trend at Station X, downward trend at Station Z.
- Nitrite-N: Downward trend at Station B, upward trend at Station D, Upward trend at Station F.
- Specific Conductance: Downward trend at Station C.
- Aluminum: Downward trend at Station C.
- Tritium: Upward trend at Station C.
- Total Suspended Solids: Upward trend at Station F, downward trend at Station X.

None of these trends appears to be a significant problem, as none of the concentrations of these constituents is high enough to warrant concern. Trending of storm water data will continue in the future.

For more details on analytical results, see Appendix A, Table A-3.

ENVIRONMENTAL SURVEILLANCE RESULTS

External Radiation

One of the exposure pathways for population groups living near DOE facilities is external radiation. The only source of external radiation at the SNL, California site is large isotopic radiation sources used for industrial radiography.

Description

Thermoluminescent dosimeters are used to measure the dose rates near SNL, California. Dosimeters are placed at the site perimeter and at more distant locations near the Livermore site. If site operations were contributing significantly to the external radiation dose, the dosimeters at the site perimeter would show a

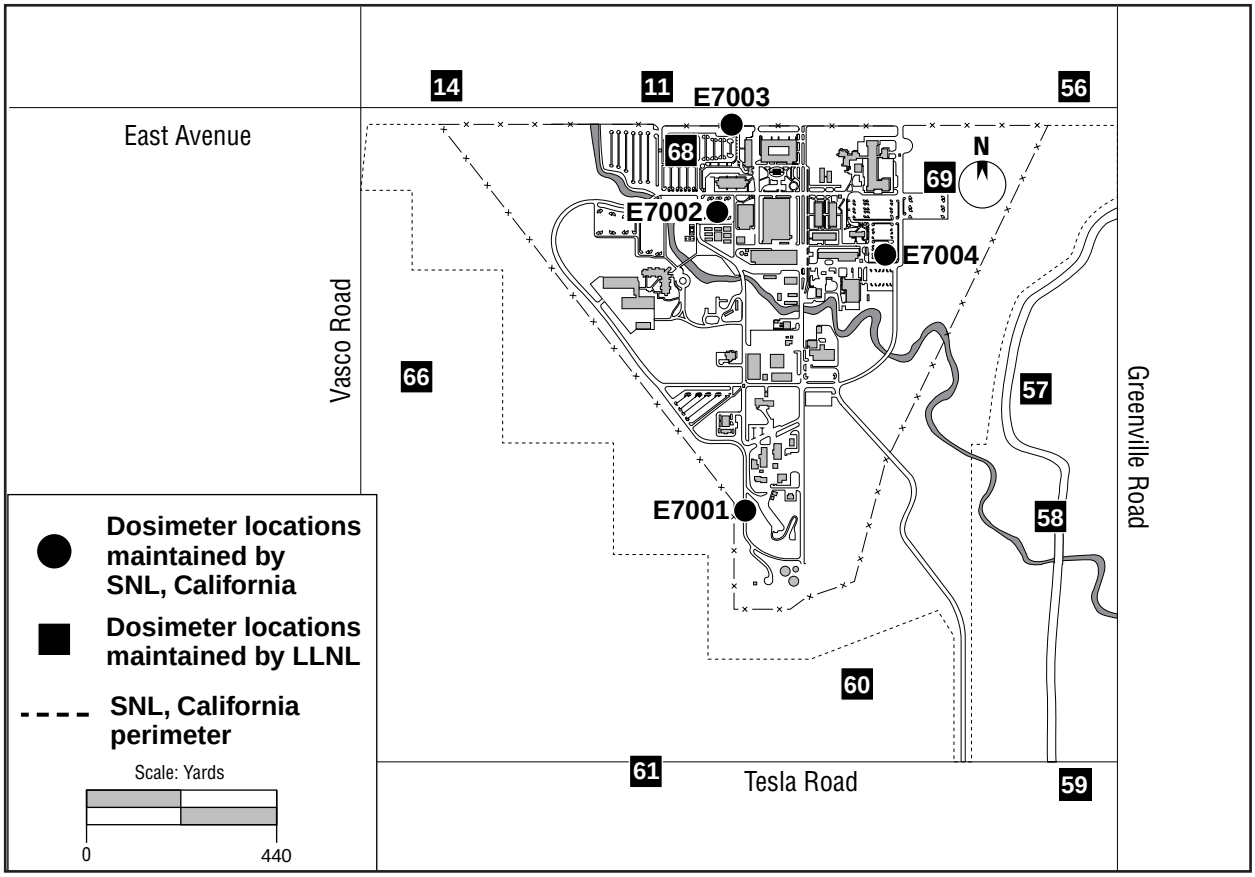


Figure 4-7. Dosimeter locations on the SNL, California site and around the site perimeter.

higher dose than those at more distant locations.

Locations

Figure 4-7 shows the locations of the dosimeters at the SNL, California site (near-field). Figure 4-8 shows off-site dosimeter locations (distant).

Methods

LLNL's Environmental Monitoring Group collects the site perimeter and off-site dosimeters quarterly. LLNL's Hazards Control Department processes them. The dosimeters are contained in Mylar bags while in the field.

The sampling locations have been chosen (per U.S. Nuclear Regulatory Commission guidance)[7] to avoid interference from large objects in the vicinity. LLNL uses Panasonic UD814 dosimeters. Each one contains three elements of thallium-activated calcium sulfate and one element of lithium borate. SNL, California uses Bicron/NE model 8807 dosimeters. Each dosimeter contains two lithium fluoride elements. SNL, California Environmental Operations Department personnel collect the four on-site dosimeters and send them to SN, New Mexico for analysis.

Quality Assurance

To be acceptable for placement in the field, all phosphors of the dosimeters must be accurate to ± 5% upon calibration. Dosimeters with a known exposure are introduced as blind samples in the processing of the field dosimeters. These are equivalent to spiked pseudo samples for the purposes of establishing the accuracy of the system. Duplicate dosimeter

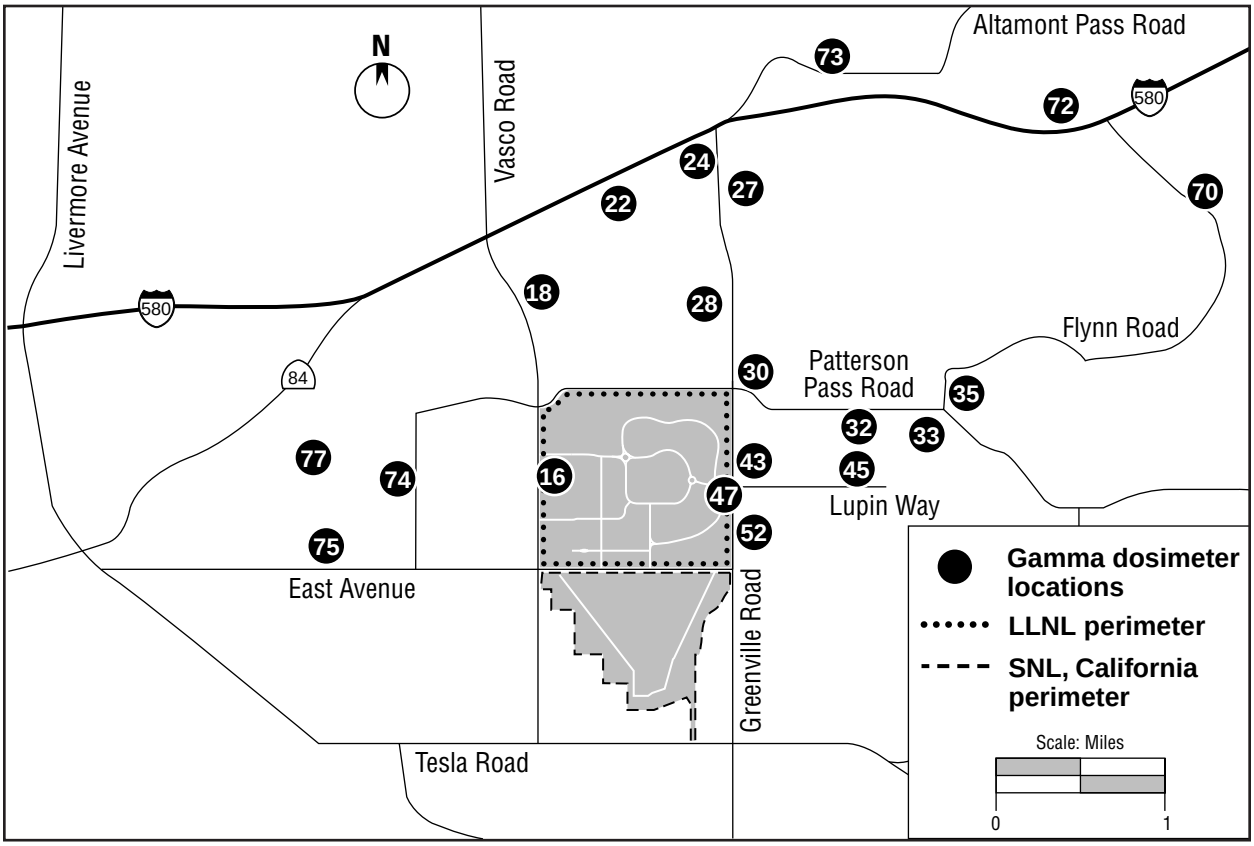


Figure 4-8. Dosimeter locations in the Livermore Valley.

packets are placed at random locations and analyzed along with the routine dosimeters. The dosimeters are calibrated by using a source that is traceable to the National Institute of Standards and Technology. The California Department of Health Services also collocates dosimeters at some of the monitoring stations to serve as an independent cross check. Exposures to the dosimeters during collection and transit are determined by the use of unexposed dosimeters (referred to as "transit controls"). These are taken on the collection route, carried with field dosimeters during transit to the laboratory, and then read for accumulated dose.

Results

The annual average external dose at the SNL, California perimeter was 58.7 mrem (0.59 mSv). The annual average external dose measured for the Livermore Valley locations was 57.8 mrem (0.58 mSv). If operations at SNL, California were producing excess external radiation, the perimeter (near-field) monitoring would show a higher dose than the more distant Livermore Valley monitoring. A Student's t-test comparing the dose at the SNL, California site perimeter and the Livermore Valley showed no significant difference.

SNL, California performed a Mann-Kendall trend test on annual average perimeter doses and valley doses for the years 1990 through 1999. The test showed no significant trends at the 95% confidence level for the perimeter and valley samples, but did show a downward trend for the valley samples at a 90% confidence level.

ENVIRONMENTAL IMPACTS

All the significant exposure pathways are sampled as a part of SNL, California's Environmental Monitoring Program. However, most of the pollutants released are at very low concentrations once dispersed in the environment. As a result, levels often are too low to determine exposure to humans directly from environmental measurements.

REFERENCES

1. U.S. DOE, Order 5400.5, *Radiation Protection of the Public and the Environment* (March 1988).

2. U.S. EPA, Title 40 CFR, Part 403, *Federal Wastewater Pretreatment Standards* (July 1983).

3. U.S. EPA, Title 40 CFR, Part 433, *Metal Finishing Point Source Category* (July 1994).

4. U.S. EPA Title 40 CFR Part 469, *Semiconductor Point Source Category* (July 1994).

5. U.S. DOE, Sandia National Laboratories/California, *Categorical Process Report* (January 1995).

6. U.S. DOE, Sandia National Laboratories/California, *Wastewater Discharge Compliance Report* (monthly).

7. U.S. EPA, Title 40 CFR, Part 136, Guidelines Establishing Test Procedures for the Analysis of Pollutants (1992, latest revision).

8. U.S. Nuclear Regulatory Commission, Regulatory Guide 4.13, *Performance Testing and Process Specifications for Thermoluminescent Dosimetry, Environmental Applications, Revision 1* (July 1977).

Table 4-1. Environmental Sampling Program Overview.

Medium	No. of Locations	Parameters	Frequency	Requiring Authority	Authority Reported to
Groundwater	29[a]	volatile and semivolatile organics, metals, general minerals, diesel, tritium, radium, and uranium. One well monitored for water level only.	quarterly	RWQCB[b] DOE Order 5400.1	RWQCB, DOE
Sewer outfall	1	metals, cyanide, BOD, COD, oil and grease[c], TDS, TSS, pH, tritium, conductivity, volatile and semi-volatile organics[d]	sampled continuously or grab; analyzed weekly or monthly	City of Livermore, Municipal Code Ch. 13.32, DOE Order 5400.1	City of Livermore, DOE
Storm water	10	conductivity, pH, TSS, oil and grease, metals, Nitrate/Nitrite tritium, cyanide ammonia COD	two storms per sampling location	City of Livermore Municipal Code Ch. 13.45, DOE Order 5400.1	SWRCB[e] RWQCB, County of Alameda, City of Livermore, DOE
External radiation	33	radiation dose	quarterly	DOE Orders 5400.5, 5400.1	DOE

[a]The number of wells sampled decreased to 13 during the second half of 1999 due to cessation of activities at the Fuel Oil Spill site. See Chapter 6, "Groundwater" for details.

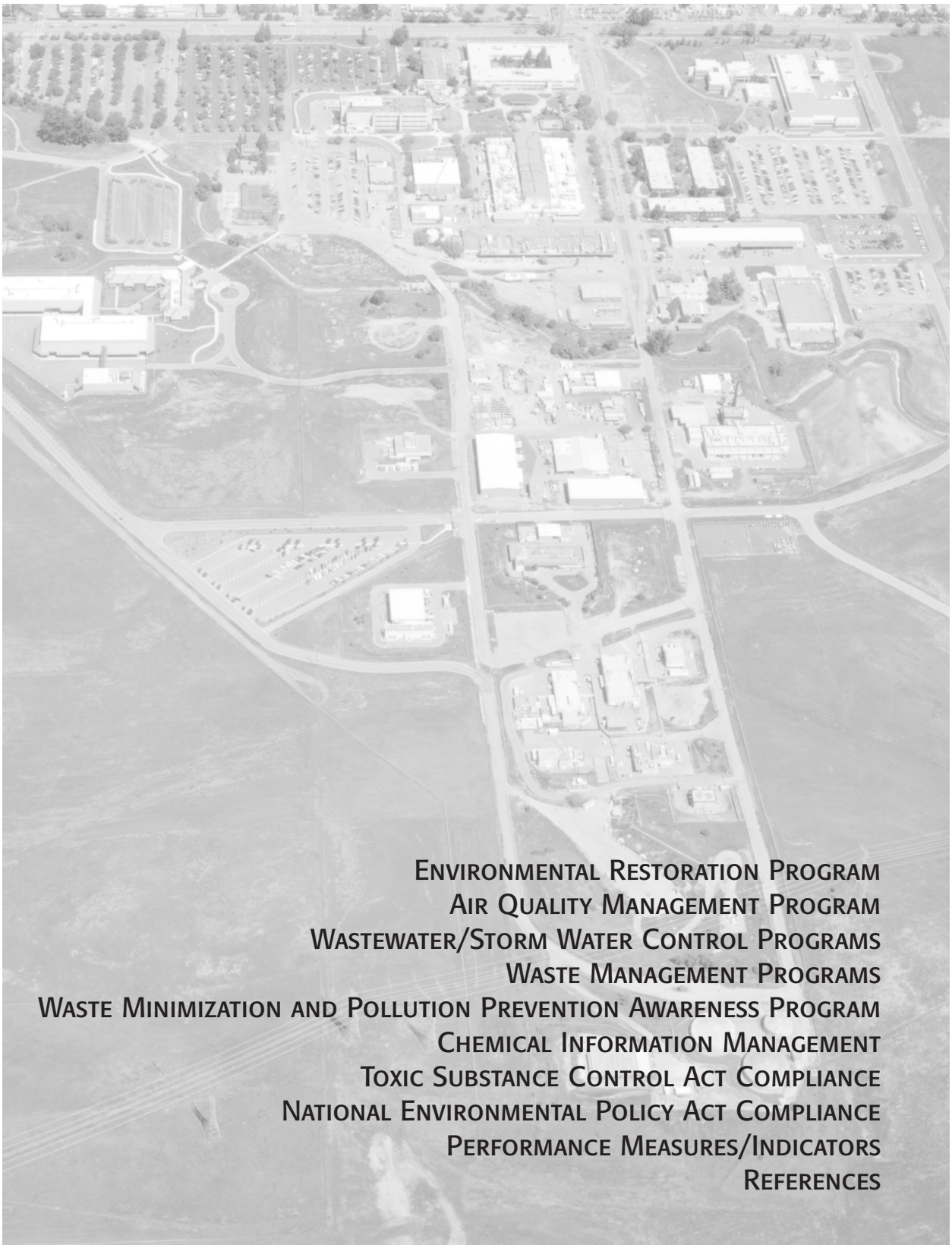
[b]Regional Water Quality Control Board.

[c]SNL, California Wastewater Discharge permit was modified by City of Livermore to suspend oil and grease from the required sampling parameters until the City Ordinance could be modified. This modification became effective May 1999.

[d]BOD = biological oxygen demand, COD = chemical oxygen demand, TDS = total dissolved solids, TSS = total suspended solids.

[e]State Water Resources Control Board.

5 — Environmental Program Information



ENVIRONMENTAL RESTORATION PROGRAM

The Comprehensive Environmental Response Compensation, Liability Act and the Superfund Amendments and Reauthorization Act mandate cleanup of toxic and hazardous contaminants at closed or inactive waste sites. Sandia National Laboratories (SNL), California activities related to these laws are being addressed under the Department of Energy (DOE) Environmental Restoration Program and are directed by the San Francisco Regional Water Quality Control Board.

During 1999, SNL, California was involved in remediating one site (Figure. 5-1): the Fuel Oil Spill. The Regional Water Quality Control Board Site Cleanup Order 88-142,[1] issued in September 1988, directs cleanup activities at SNL, California. This Order was modified in 1989 for the Fuel Oil Spill (Order 89-184).[2] The Engineering for Information

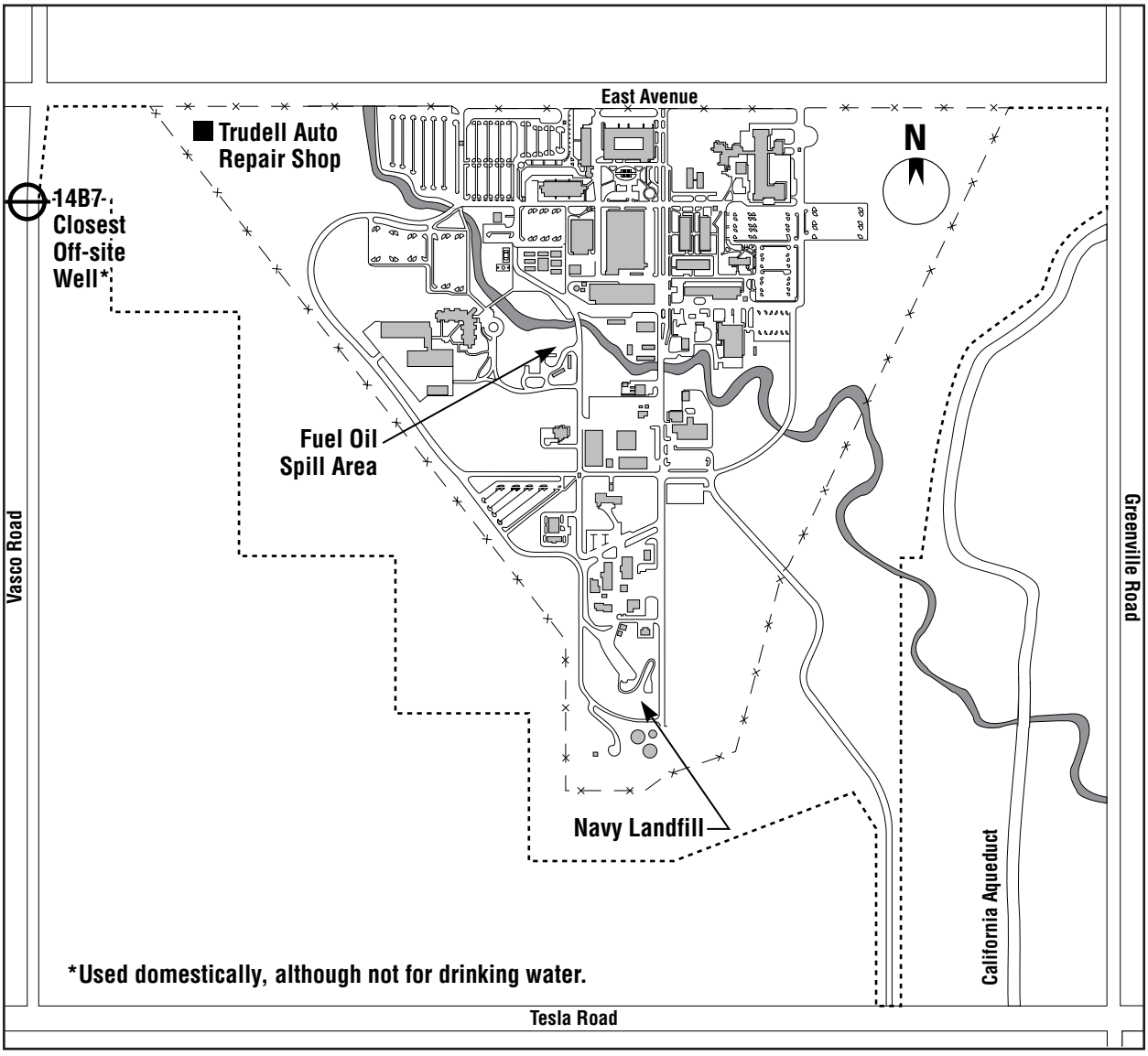


Figure 5-1. SNL, California remediation sites.

Systems Department is conducting these restoration activities, as described below.

Fuel Oil Spill (FOS)

In 1975, as the result of an accidental puncture of an underground transfer line, 59,500 gallons of #2 diesel fuel spilled into the vadose zone from an above-ground reserve fuel tank. SNL, California has monitored the groundwater in this area since 1985. It shows occasional low-level contamination with fuel oil components. Neighboring farmers sometimes use this aquifer as a source of drinking or agricultural water.

SNL, California completed a remedial investigation of the spill site in November 1988. In 1990, SNL, California, Argonne National Laboratory, and the University of Notre Dame performed several bench-scale tests to determine the most effective means of cleanup. The resulting treatability report indicated that bioremediation would be the most effective of the technologies tested in reducing fuel oil contamination. In 1991, in situ bioremediation tests were done. Bioremediation was proven effective, but in the field it proceeds at a slower rate than laboratory tests done in slurry reactors.

In December 1990, Argonne began groundwater flow and contaminant transport modeling to support the pilot bioremediation system design. Using a computer code developed at Los Alamos National Laboratory and monitoring well data, experts at Los Alamos prepared a three-dimensional model characterizing the spill area. Argonne conducted additional bench-scale studies at Notre Dame to establish required nutrient and oxygen levels and to identify degradation products. SNL, California completed three groundwater wells downgradient of the spill site to control and monitor the spread of the contaminated groundwater.

After heavy rainfall in the spring of 1993, the groundwater at the Fuel Oil Spill site rose about 3.6 m (12 ft). Diesel and benzene, toluene, ethylbenzene, and xylene (BTEX) contamination were noted during the second-quarter groundwater sampling. As a result, the Regional Water Quality Control Board directed SNL, California to implement an Interim Remedial Measure, a groundwater treatment system. Because SNL, California planned to move the system to a permanent location (to serve as the water treatment system for the Fuel Oil Spill pilot study nutrient injection and withdrawal systems), it was termed the "Temporary Interim Remedial Measure."

In the fall of 1993, the Regional Water Quality Control Board approved SNL, California's work plans for the FOS pilot study and the Temporary Interim Remedial Measure. SNL, California completed the FOS site plan in October 1993. In December 1993, the Temporary Interim Remedial Measure work plan and system design were completed.

SNL, California completed site preparation—including fencing, gates, site grading, gravel, and paving—in December 1993. Using the conceptual design from Argonne National Laboratory, SNL, California installed a free product separator and carbon filtration beds in January 1994. The Temporary Interim Remedial Measure went on line in early February 1994.

In March and April 1994, SNL, California drilled ten monitoring boreholes and installed downhole instrumentation, five injection/withdrawal wells, four withdrawal wells, and five geophysical logging boreholes. SNL, California set up a small land farm (ex situ bioremediation) to treat the drill cuttings from the wells and boreholes. The land farm reduced the contamination in the withdrawn soil to less than 50 ppm. In 1995, the land farm was closed.

During the summer of 1994, utility hookups were completed, and the data acquisition software was finished and installed. Following these activities, SNL, California installed a subsurface infiltration gallery, seven tensiometers, and a

remote barometer at the pilot study site. Multiplexers and data loggers were installed and connected to the computers. The data collection computer system began baseline monitoring for temperature, pressure, and soil moisture. This system comprised 158 information channels collecting data once every minute, 24 hours per day.

In late November 1994, SNL, California completed the construction of the pilot study system. The components of the Temporary Interim Remedial Measure were moved into the pilot study system and tested.

SNL, California conducted a small-scale, flow-through test in April 1995. The bioremediation pilot study began in June 1995, with the first phase of the process: injection of water into the ground. The water contained the necessary nutrients for in situ bacterial growth: nitrogen and phosphorus, with calcium and magnesium salts added to modify the soil properties. Using low to moderate flow rates of 1.5 to 6.0 gallons per minute, SNL, California technicians injected nearly 2,000,000 gallons of water into the contaminated soil.

In October 1995, the injection system was shut down, and the second, withdrawal phase began. About 60,000 gallons of water were removed and treated; the rest remained in the pores of the soil to facilitate the bioremediation.

In November 1995, the third phase—aeration—began. Air was forced into the soil and then pulled from the soil at a low rate (about 5 ft^3 per minute). This phase continued through the end of 1995.

In 1996, the cycles (nutrient injection, withdrawal, and aeration) continued. The year ended with the third injection phase which began on September 24. The nutrient mix for the third injection phased consisted of 25 mg/L of ammonium nitrate and 1 mg/L of phosphoric acid. Nutrients were injected through all eight pilot study injection points along with the infiltration gallery at a flow rate of 1.5 gallons/minute at each location. The third-cycle, nutrient injection was completed on December 12. Approximately 842,000 gallons of water and nutrient were injected through the injection wells and 199,000 gallons through the infiltration gallery.

During the second half of the 1996, SNL, California began performing carbon dioxide (CO_2) measurements in the monitoring wells within the pilot study area. The CO_2 concentrations were extremely high, which indicated that significant biodegradation was occurring. Later, monitoring wells outside of the pilot study area were sampled, and significant CO_2 levels were found in the wells where contamination was located. This suggests that the pilot study injections were affecting an area substantially larger than the pilot study area. Work continued with the CO_2 measurements to determine the level of biological activity and the area being impacted by the pilot study bioremediation.

In 1997, the injection, withdrawal, and aeration phases continued as scheduled. In April, near the end of the fourth cycle injection phase, five boreholes (three were completed as wells) were drilled in order to perform soil sampling in locations adjacent to the pilot study area. The goals of the soil sampling were to better determine the horizontal extent of the pilot study bioremediation and to more accurately determine the levels of diesel cleanup. It was determined from the boreholes that the area being remediated was significantly larger than the pilot study area especially at the 50-100 foot depths. Cleanup levels were found to vary from location to location with the greatest levels of cleanup at the deeper depths. The CO_2 levels, total petroleum hydrocarbon (TPH) sampling, lysimeter sampling, and the soil sampling data all compare favorably.

The fifth cycle injection phase began and ended in May 1997. This was followed by the aeration phase, which ended in the middle of September. The fifth cycle nutrient injection phase began

September 15 and ended October 31. All injection cycles, since cycle two, were completed by injecting approximately one million gallons of water and nutrient. The fifth cycle withdrawal phase began on November 3 and ended on November 23. The aeration phase began on November 24 and continued through the end of the year.

The sixth cycle injection phase began in March 1998 and ended in April. Approximately one million gallons of water and nutrient were injected during this time. The injection cycle was followed by the withdrawal cycle which lasted approximately one month. This was followed by the sixth aeration cycle. The aeration cycle continued through the end of the year.

During a site visit with the Regional Water Quality Control Board (RWQCB), SNL, California and the RWQCB representative decided that because of the new information concerning diesel spills (Leaking Underground Fuel Tank study etc.) that full scale bioremediation might not be necessary for the Fuel Oil Spill site. Since the contamination has been present without much movement since the mid 70s it was decided that SNL, California would perform a risk assessment (using the American Society of Testing and Materials (ASTM) standard for diesel spills) and seek a risk-based closure of the Fuel Oil Spill site. In 1998, a risk assessment and closure request were submitted to the RWQCB. The risk assessment was performed using the ASTM standard for diesel spills. The RWQCB accepted the risk assessment but asked for additional information to determine plume stability before making a closure decision. SNL, California provided this additional data package in January 1999. The additional data included plume stability information and concentration versus time plots along with another request for closure of the site.

In July of 1999, SNL, California received permission from the RWQCB to shutdown the in situ bioremediation operation at the Fuel Oil Spill site. The sixth cycle aeration phase, which began on June 3, 1998 was officially shutdown on July 12, 1999. This formally completed the six bioremediation cycles at the FOS site. At the same time, the aquifer protection wells along with the groundwater treatment system were shutdown. As part of the FOS site shutdown, the RWQCB is allowing SNL, California to dismantle the bioremediation system and associated infrastructure. The RWQCB requested that SNL, California continue quarterly monitoring at six wells. The six wells are FM-1, FM-6, FM-7, FM-8, FDG-1 and FDG-3. These wells sufficiently bound the plume, and one of the wells (FM-1) is near the spill release point. The monitoring of these wells will allow SNL, California to verify plume stability and confirm that benzene and TPH levels continue their decreasing trend. At the end of two years, SNL, California will meet with the Board to evaluate the monitoring data and determine whether final closure of the monitoring wells is appropriate.

Dismantlement activities were mostly completed in 1999 at the 2.6-acre FOS site. Forty-three wells were pressure grouted according to Zone 7 permit requirements. All surface piping was removed prior to well abandonment. Abandonment procedures included filling wells and open boreholes with grout, excavating and removing the upper five feet of well materials and backfilling the excavated areas with clean material. The basic guidelines that were followed for the well abandonment can be found in the ASTM Standard D5299-92, Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities (ASTM, 1993). The tensiometers and the infiltration gallery were removed in their entirety. All of the bioremediation and treatment systems have been removed. The fence around the perimeter of the site has also been removed. All but one of the trailers

were removed from the site along with electrical systems, roads, and other concrete and pavement. The site was graded and the plan is to remove the one remaining trailer and add a paved trail and trees to complete the restoration of the FOS site in 2000.

Navy Landfill (NLF)

An inactive landfill is located at the southern end of the SNL, California site. It was used by the Navy during and shortly after World War II, and again by Lawrence Livermore National Laboratory (LLNL) in the 1950s and early 1960s. A survey of historical records and landfill contents indicated that only general construction debris and machine turnings were disposed of at the site. There is no indication of any hazardous materials being buried at this landfill. The landfill measures approximately 11,300 m^2 in area and 68,800 m^3 in volume.

The landfill appeared on the State of California's Solid Waste Water Quality Assessment Test Program list in December 1987. Consequently, the State required a wastewater quality assessment test proposal (equivalent to a remedial investigation plan). DOE/Kirtland Area Office (KAO) and SNL, California submitted the proposal in March 1993 and a report was submitted in 1994.[3,4]

To characterize the site, SNL, California installed an upgradient well, three downgradient wells, a piezometer, and two lysimeters. Two additional wells were installed in 1993, under the direction of the Regional Water Quality Control Board, to provide additional information about the groundwater at the site.

In November 1994, SNL, California received a recommendation for closure of the landfill from the State Water Resources Control Board (SWRCB).

After further review of the site data in early 1996, SNL, California and DOE suggested that an enlarged cover over the NLF may not be necessary to protect human health and the environment.

In August 1996, the DOE submitted to the RWQCB a request for Inert Classification. The DOE and SNL, California requested that the NLF be categorized as containing only inert waste. Therefore, the landfill is not subject to the closure requirements in California Code of Regulations (CCR) Title 23, Chapter 15, Article 8. The data presented in the request support the conclusions that 1) the NLF contains only inert waste, 2) the NLF waste is not degrading the quality of groundwater, and 3) the NLF in its current state does not pose a threat to the public health or environment.

During a site visit in March of 1997 to discuss the request for Inert Classification, the RWQCB stated that Inert Classification would be extremely difficult to obtain. The RWQCB suggested that DOE/KAO and SNL, California perform a risk assessment of the NLF and seek a risk-based closure of the site. In October of 1997, a risk assessment and closure plan were submitted to the RWQCB. The closure request was approved in March 1998. Closure of the NLF was approved if the following conditions were satisfied:

1. Groundwater monitoring is continued on a quarterly basis at monitoring well NLF-6, where carbon tetrachloride is intermittently detected.
2. An adequate vegetative cover is applied to the landfill, such that there are no exposed areas.
3. Erosion control measures are followed in accordance with the submitted erosion control plan.

Erosion control measures were implemented at the NLF site beginning April 1, 1998. The use of herbicides for weed control and fire protection has ceased, which will significantly alleviate the potential for erosion. Erosion control measures outlined in the erosion control plan will continue.

Because of the late, spring rains, the cleanup of the NLF site did not begin

until June 22, 1998. The objective was to remove all debris (concrete, re-bar, etc.) not integral to the composition of the hillside. During the thirteen-day duration of the project, a total of 31.6 tons of concrete rubble, monoliths and debris was removed and disposed of at an offsite landfill. All areas were inspected to ensure that loose debris was removed and that all exposed re-bar was cut at or below ground level. Two areas that had shown signs of eroding were repaired. All exposed areas resulting from removal activities were backfilled with clean, imported materials and hydroseeded for erosion control. Additionally, all eight of the explosive magazines that are located just outside the NLF boundary were covered with erosion control mats to prevent further wind and rain erosion.

Five monitoring wells and two lysimeter wells were pressure grouted by a California licensed driller. The well heads were removed and destroyed per the requirements of the Zone 7 Well Destruction Permit. The destroyed wells were filled and finished to match the surrounding areas. All NLF site closure activities were completed on July 9, 1998.

SNL, California and DOE now consider the NLF a closed site. All of the RWQCB closure conditions have been satisfied. Monitoring will continue at NLF-6. The erosion control plan will be followed. At the end of two years we will evaluate the sampling results from NLF-6 and the stormwater sampling results will be evaluated to determine if continued sampling is warranted.

Underground Storage Tank Management

SNL, California complies with Federal and State requirements for underground storage tanks (UST).[5] At the beginning of 1999, SNL, California had two regulated underground storage tanks. Both tanks were disconnected and drained on December 21, 1998 because they had minor deficiencies, which precluded them from being compliant with the new UST regulations.

One 500-gallon tank was installed in a vault behind Building 964 in 1986 to store diesel fuel for emergency power generators. It is constructed of double-walled fiberglass and is equipped with a Leak Alert(tm) system (Universal Sensors & Devices), which meet all tank-monitoring requirements.[5] The Leak Alert(tm) system has two sensors—metal-oxide semiconductors—which detect organic vapors. These sensors are connected to a signal panel, which emits both audio and visual alarms. This tank's overfill protection system was upgraded along with the addition of a new drop tube and striker plate under Alameda County Health Agency oversight. The Building 964 tank is now fully functional and permitted through July of 2004.

The second UST was a 950-gallon steel tank in a containment vault located below grade, north of the former Tritium Research Laboratory. This tank stored diesel fuel for the building's emergency generator. The tank had minor deficiencies and was also located in an open to the weather vault.

This tank was formally removed under Alameda County Health Agency oversight in May 1999. A 500-gallon Convault above ground storage tank has replaced the tank. This leaves SNL, California with only the Building 964 UST.

Spill Prevention Control and Countermeasure Plan

The Spill Prevention Control and Countermeasure Plan establishes procedures for controlling, and if necessary, remediating oil spills at SNL, California.[6] The plan was prepared in accordance with Title 40 CFR, Part 112.[7] It was approved in June 1997. This Plan will be updated in early 2000. Site personnel have been trained in spill response procedures.

AIR QUALITY MANAGEMENT PROGRAM

Operations at SNL, California are subject to the rules and regulations of the Bay Area Air Quality Management District (BAAQMD), the State Air Resources Board, and the Environmental Protection Agency (EPA), which have jurisdiction over facilities that emit air contaminants. In 1999, SNL, California continued activities to assure site-wide compliance with air quality regulations. These activities are directed toward ensuring adequate evaluation of air permit requirements and other applicable regulations.

SNL, California's Air Quality Management Program identifies and evaluates potential sources of air pollutants, and documents compliance requirements. The Environmental Operations Department's Air Quality Program maintains the site-wide air emissions source inventory, which provides data on materials, equipment, and operations that are subject to air quality regulations. The Air Quality Group also prepares applications for air permits or exemption requests as needed in conjunction with this inventory.

In 1999, SNL, California operated 24 permitted sources and 29 exempt sources (see Chapter 3, "Compliance Summary"). SNL, California reports air emissions from these sources to the BAAQMD as part of the annual permit renewal.

WASTEWATER/STORM WATER CONTROL PROGRAMS

Wastewater Management Program

The primary goal of the Federal Clean Water Act is to protect and restore the integrity of the nation's waterways. The Clean Water Act establishes the National Pollutant Discharge Elimination System (NPDES), which requires permitting of all point-source liquid effluent discharges. These permits contain specific criteria for discharging liquids to waterways. The State of California has authority to enforce the requirements of the Clean Water Act. The Livermore Water Reclamation Plant is responsible for issuing and enforcing SNL, California's wastewater permit. The permit contains specific pollutant limitations and monitoring requirements for discharging wastewater to the municipal sewer system.

During the last few years, the EPA has implemented more stringent regulations governing industrial wastewater discharges to public sewer systems. SNL, California has maintained a program to control liquid effluents. This program incorporates administrative and engineering controls to prevent contaminated wastewater from being discharged to the municipal sewer system.

SNL, California has developed a Wastewater Minimization Program to reduce pollutants in wastewater discharge, protect the environment, and ensure compliance with Federal, State, and local regulations. SNL, California has also developed a web page for SNL, California's internal web. The web page provides general guidelines to SNL, California personnel about what can and cannot be discharged into the sanitary sewer system. Twice a year a notice is placed in the daily bulletin (TNT) to remind the SNL, California personnel that they must comply with these guidelines.

Liquid Effluent Control Systems

The Liquid Effluent Control Systems (LECS) are key elements of SNL, California's wastewater management. The LECS comprise large, monitored, holding tanks, which collect and retain wastewater generated at key facilities. These systems allow SNL, California to analyze the wastewater and verify that its constituents are within acceptable limits before discharging it to the sanitary sewer system. SNL, California has six LECS in operation, at the following locations (see Fig. 4-1 in Chapter 4): Building 913

(miscellaneous laboratories), Building 910 (Printed Wiring Laboratory), Building 961 (Hazardous Waste Facility), Building 968 (the Chemical and Radiation Detection Laboratory), Building 906 (Combustion Research Facility), and Building 941 (Integrated Manufacturing Technologies Laboratory).

Sewer Diversion Facility at LLNL

The combined SNL, California and Lawrence Livermore National Laboratory (LLNL) sewer effluent is discharged to the City of Livermore municipal sewer system at the northwest corner of the LLNL site. To better control effluents and increase protection of the Livermore Water Reclamation Plant, LLNL and SNL, California constructed a sewer diversion facility at LLNL. This system can retain approximately 200,000 gallons of contaminated sewage on site, if necessary, for further evaluation.

Storm Water Management Program

Amendments to the Clean Water Act in 1987 require permits for storm water discharges from municipal storm drain systems and storm water discharges associated with industrial activities.

In 1990, the EPA published specific permit requirements. With permitting authority, California's State Water Resources Control Board adopted the Industrial Activities NPDES Storm Water General Permit in 1991, which was reissued in April 1997. It allows industrial facilities in California* to be in compliance with the Federal storm water permitting requirements by filing a Notice of Intent with the Board. SNL, California has filed a Notice of Intent and must comply with the requirements of the permit.

Although the SWRCB administers the storm water permit, SNL, California is regulated by the Regional Water Quality Conrol Board (RWQCB).[8]

In response to the permitting requirement of the Federal Clean Water Act for municipal storm water discharges, the City of Livermore and Alameda County Flood Control & Water Conservation District adopted ordinances that also require SNL, California to manage storm water discharges to the municipal storm drainage system. However, under a memorandum of understanding with the RWQCB, the RWQCB is the lead regulatory agency for federal facilities such as SNL, California.

SNL, California complies with Federal, State, and local storm water requirements through a comprehensive Storm Water Management Program. This program includes the Storm Water Pollution Prevention Plan and the Storm Water Monitoring Program.

Storm Water Pollution Prevention Plan

The Storm Water Pollution Prevention Plan identifies activities that result in non-storm water discharges to the storm drain system and describes how these discharges are eliminated.[9] It identifies sources and activities that could allow pollutants to be deposited on impervious surfaces and picked up by storm water runoff. It also describes how SNL, California minimizes these pollutant sources discharged with storm water runoff by implementing best management practices.

Because the SNL, California site continually changes, the *Storm Water Pollution Prevention Plan* is a living document. It is updated regularly to reflect these changes.

Storm Water Monitoring Program

The purpose of the Storm Water Monitoring Program is to optimize SNL, California storm water pollution prevention activities. It consists of extensive visual inspection and sampling activities, which include:

* *The California General Industrial Activities NPDES Storm Water Permit applies to regulated facilities throughout California, except facilities located in Santa Clara County. The San Francisco Bay Regional Water Quality Control Board has adopted a separate NPDES permit for facilities in Santa Clara County.*

- *Quarterly Visual Inspection for Non-stormwater Discharges*—Under the general permit, certain non-stormwater discharges without pollutants are authorized to discharge to the storm drains. Quarterly visual inspections are performed for non-stormwater discharges. Inspectors look for unauthorized non-stormwater discharges from the site and visually observe authorized non-stormwater discharges and their sources to ensure there are no pollutants.
- *Wet Weather Visual Inspection*—SNL, California also inspects all storm drain outfalls discharging into the site's two main storm water conveyances during storms to see if storm water runoff picked up visible pollutants from the site. These inspections are conducted once per month from October through April, during storms that produce runoff.
- *Storm Water Sampling*—When there was enough to produce runoff, SNL, California collects storm water samples from up to ten sampling locations. This sampling is performed during at least two separate storms. The exception is location N that was added beginning with the 1997/1998 wet season. Chapter 4 describes each sampling location and the results of SNL, California's storm water-sampling activities in 1999.
- *Annual Site Inspection*—The annual site inspection ensures that best management practices were effectively implemented. Findings from the site inspection were used to evaluate and update the Storm Water Pollution Prevention Plan.

Storm water monitoring information is used to identify potential sources of pollutants and non-storm water discharges.

In 1999, SNL, California completed all wet weather visual inspections, the annual site inspections, and the quarterly visual inspections for non-stormwater for July through September. Storm water sampling is conducted during the wet season October-May. The calendar year 1999 included two different wet seasons October 1998–May 1999 and October 1999–May 2000. In 1999, ten locations were sampled for the 1998-1999 wet season and four locations were sampled for the 1999-2000 wet season SNL, California will complete the remaining sampling required for the 1999-2000 wet season in 2000.

WASTE MANAGEMENT PROGRAMS

The Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984, requires a comprehensive program for managing hazardous wastes from generation to ultimate disposal. The primary goals of RCRA are to reduce the volume and toxicity of wastes and to minimize the amount of waste requiring land disposal. The California Hazardous Waste Control Law is similar to, but more restrictive than, RCRA. The EPA authorized the State to assume RCRA authority in August 1992. This authority is enforced by the California Environmental Protection Agency's (Cal/EPA's) Department of Toxic Substances Control.

Hazardous waste activities at SNL, California include collection, on-site transportation, consolidation, treatment, and storage of energetic, radioactive, mixed, and nonradioactive hazardous wastes. SNL, California has not and does not plan to dispose of hazardous wastes at the site. SNL, California was granted a RCRA Part B Permit for the storage of hazardous waste in January 1993. The permit is effective until January 2003.

Hazardous Waste Program

Hazardous waste is defined as a material with no further end use, which is not radioactive, but contains constituents that may be harmful to human health or the environment. RCRA wastes are regu-

lated by the EPA and the Cal/EPA. Non-RCRA wastes are regulated by the Cal/EPA.

SNL, California sends all nonradioactive wastes generated on site to permitted commercial facilities for treatment or disposal.

Low-Level Radioactive Waste Program

The low-level radioactive waste management activities at SNL, California include handling, packaging, and storing of radioactive waste. Most of the program work completed this year was shipments of waste to Nevada Test Site. Less than 10 m3 of waste from other research and development activities are in the storage facility, packaged in Department of Transportation (DOT) specification containers. No transuranic or high level radioactive waste are generated at the SNL, California site.

Mixed Waste Program

Mixed waste is a RCRA hazardous waste that also contains radionuclides. SNL, California's Mixed Waste Program has taken major steps to meet compliance objectives of the Federal Facilities Compliance Act. SNL (both the California and the New Mexico sites) has consolidated all cost and compliance liability associated with the storage, treatment, and disposal of mixed waste. As of March 30, 1995, SNL, California met all compliance requirements for the Federal Facilities Compliance Act. Mixed waste generated at SNL, California (which averages less than 0.4 m^3 per year) has been shipped from point-of-generation to SNL, New Mexico or to other permitted treatment facilities for management.

WASTE MINIMIZATION AND POLLUTION PREVENTION AWARENESS PROGRAM

SNL, California has supported various waste minimization activities since 1985. These efforts have evolved into the Waste Minimization and Pollution Prevention Awareness Program. The program's principal objective is to maximize all opportunities for eliminating or minimizing waste through source reduction, reuse, and recycling. Waste that cannot be reduced, reused, or recycled is treated through available treatment technology or sent out for disposal. The program reflects ongoing efforts to integrate pollution prevention and waste minimization into the site's operating philosophy. The increases in waste management costs and the public's interest in environmental issues provide added incentives for an effective program.

SNL, California has implemented a variety of waste minimization techniques. These are supported by employee training programs aimed at reducing waste while meeting the company's requirements for quality, productivity, safety, and environmental compliance.

A key element of the Waste Minimization and Pollution Prevention Awareness Program is the development of baseline information on waste generation. The Sandia Pollution Prevention Program's primary functions are to make all SNL, California employees aware of the program, identify tasks to implement the program, and provide a mechanism for communicating waste minimization issues within the SNL, California community and to the public. The Pollution Prevention Program is responsible for assisting in the development, design, creation, and implementation oversight of waste minimization projects. Waste generators are responsible for implementing the program.

SNL, California's waste minimization and pollution prevention efforts demonstrate both the commitment and involvement of SNL, California's management and staff. These efforts include the following:

- Waste Minimization and Pollution Prevention awareness has been

incorporated into several required Environment, Safety, and Health (ES&H) training courses and is provided at monthly new-hire orientations.

- SNL, California annually holds an employee awareness program on environmental issues. In 1999, during the annual "Bring Your Daughters to Work" and "Bring Your Sons to Work" events, and at SNL, California's open house, the Pollution Prevention Program presented information and a demonstration on completing the recycling loop by purchasing products that contain post-consumer recycled material.
- The corporate Solvent Substitution Technical Advisory Committee and Chlorofluorocarbon Elimination Working Groups help users find less hazardous or non-hazardous solvents and cleaning agents.
- SNL, California employees substitute safe alternatives for hazardous chemicals whenever possible.
- SNL, California's trip reduction program continues to reduce air pollution by reducing vehicle trips to the site.
- Green waste is collected and disked into the fields. Branches and shrub cuttings are processed through a shipper/shredder and used in weed control and ground covering.
- In 1999, SNL, California's recycling program diverted over 89 metric tons of waste from the landfill.
- The Property Reapplication and Reclamation Department reassigns excess equipment to other SNL, California organizations or to organizations outside of Sandia. In 1999, Sandia/California donated more than 106 computers and related equipment, valued at $142,780, and other miscellaneous equipment, valued at over $8,000 to local schools and the National Park Service.
- The SNL, California site recycles office paper, miscellaneous paper, cardboard, aluminum cans, scrap metal, glass, tires, carpet tiles, construction debris, fluorescent light tubes, and transparencies.
- SNL, California recycles hazardous wastes whenever possible. Some examples are batteries, coolants, petroleum oil, empty drums, and lead. The Waste Management Group also recycles non-hazardous laboratory glass.

The Waste Management Department tracks all regulated waste generation information. The Facilities Operations and Property Management departments track and maintain all non-hazardous waste information. The quantities listed in Table 5-1, except for sanitary waste, are based on the manifested shipment database for calendar years 1998 and 1999, respectively.

Table 5-2 shows the results of SNL, California's recycling efforts in 1999.

CHEMICAL INFORMATION MANAGEMENT

The Environmental Operations Department implemented a site-wide Chemical Information System/Material Safety Data Sheet management system in 1992. This system is designed to help SNL, California more effectively comply with Federal, State and local regulations and DOE orders, and to improve the operating efficiency in chemical work areas. It is a computer database, which tracks chemical containers in facilities by barcode labels. It has several unique features, including flexible software, which permits SNL, California to customize it for the inventory's special needs. The system provides detailed information on chemical inventory and usage on site, thus supporting numerous ES&H programs and activities. These major programs and activities include:

- Chemical Information Management—Emergency Planning and Community Right-to-Know Act (EPCRA) and the California Hazardous Material Management Plan reporting;
- Industrial Hygiene—Chemical Information for Personnel Hazards Communication Information (Employee Right-to-Know/Material Safety Data Sheets);
- Health Physics—radioactive material tracking;
- Waste Management—waste container tracking and hazardous material and spill information;
- Pollution Prevention—chemical inventory and usage on site;
- Air Quality—chemical inventory and usage on site;
- Storm Water/Wastewater—chemical inventory and usage on site;
- Emergency Preparedness—chemical inventory, hazardous material information, and spills;
- Fire Protection—chemical inventory and hazardous material information;
- Explosives-hazardous material information;
- General resource for ES&H and Laboratory—wide audits, surveys, and information requests.

TOXIC SUBSTANCE CONTROL ACT COMPLIANCE

The Toxic Substance Control Act (TSCA) establishes regulations to control the use of and exposure to new industrial chemicals. It identifies toxic substances and regulates their manufacture, use, storage, handling, and disposal. TSCA requires premanufacturing notification and evaluation of new chemicals to assess the health and environmental risks. It also regulates the use, inspection, and disposal of polychlorinated biphenyls (PCBs).

The Lead/Asbestos Abatement Program (Department 8821) works closely with SNL, California maintenance and facilities personnel in order to identify and properly deal with any asbestos-containing or lead-containing materials encountered during maintenance or construction activities.

NATIONAL ENVIRONMENTAL POLICY ACT COMPLIANCE

During 1999, 130 SNL, California projects were evaluated, and the National Environmental Policy Act (NEPA) classifications and/or determinations made. Of the projects evaluated, 114 underwent SNL, California internal review and were classified as included within the scope of existing documentation. Existing NEPA documentation at the California site includes the site-wide Environmental Impact Statement (EIS) and eight umbrella categorical exclusion determinations. The remaining 22 projects were transmitted to the DOE/KAO for NEPA determinations. All 22 projects that required a DOE/KAO determination were found to be categorically excluded from the need to prepare an environmental assessment or environmental impact statement.

At least every five years, DOE is required to evaluate the EIS and determine if a supplement analysis is required. In 1997-1998, DOE conducted an initial evaluation and determined that a supplement analysis was not needed and that the EIS remained adequate for SNL, California in its description of activities and impacts within NEPA. Based on a decision by DOE Defense Program Office, DOE included Sandia in the *Supplement Analysis for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore* (DOE/EIS-0157-SA-01).[10] The Supplement Analysis concluded that SNL, California continues to operate within the levels described in the 1992 EIS and that supplementation of the 1992 EIS/EIR was not needed for SNL, California activities.

PERFORMANCE MEASURES/INDICATORS

Environment, safety, and health performance has been measured using performance indicators at Sandia for many years. However, the program has had a limited scope. Currently, SNL, California has a defined hierarchy of performance indicators, with a comprehensive set of lab-wide indicators at the top and more detailed, organization-specific indicators at the bottom.

For reporting to the DOE, the top-level indicators are categorized into four general areas: protection of people, protection of the environment, compliance, and management practices; and two types: outcomes and precursors.

The top-level precursor indicators are derived from lower level indicators, which have been developed and used by organizations to safely manage their workplaces to achieve the desired overall ES&H outcomes. The outcomes indicators measure and trend the overall ES&H performance at SNL, California, whereas the precursor indicators may show trends in the performance of ES&H processes intended to achieve those outcomes. The correlation of process performance to outcomes performance is used to pinpoint key performance indicators to monitor ES&H.

An ES&H Oversight Pilot team, which consists of both SNL, California and DOE representatives, is developing an updated set of corporate ES&H performance indicators for SNL, California to meet the needs of the DOE's current performance-based oversight and assessment objectives. The SNL, California organization responsible for this effort is the Emergency Management and Operations Evaluation Department. These new performance indicators will be designed to show trends before significant problems occur and will become a key part of the ES&H portion of the annual DOE/KAO multiprogram laboratory appraisal of SNL, California. The top-level indicators will evolve to include proven key indicators. Each SNL, California division will be responsible for developing its own set of performance indicators that can be used to measure performance. These also will be evaluated during the annual DOE/KAO multiprogram laboratory appraisal of SNL, California.

REFERENCES

1. State of California, San Francisco Bay Regional Water Quality Control Board, Order 88-142 (September 21, 1988).

2. State of California, San Francisco Bay Regional Water Quality Control Board, Order 89-184 (December 13, 1989).

3. U.S. DOE, Sandia National Laboratories/California, *Navy Landfill Solid Waste Water Quality Assessment Test Proposal* (March 1993).

4. U.S. DOE, Albuquerque Operations Office, *Navy Landfill Solid Waste Water Assessment Test Report* (June 1994).

5. State of California, Title 23 CCR, Division 3, Subchapter 16, "Underground Storage Tank Regulations" (1994).

6. U.S. DOE, Sandia National Laboratories/California, *Spill Prevention Control and Countermeasure Plan* (June 1997).

7. U.S. EPA, Title 40 CFR, Part 112, Oil Pollution Prevention (July 1992, latest revision).

8. State of California, California Administrative Code, Title 22, "California Domestic Water Quality and Monitoring Regulations" (1977).

9. EOA, Inc., *Storm Water Pollution Prevention Plan, for Sandia National Laboratories/California* (August 1999).

10. S*upplement Analysis for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore* (DOE/EIS-0157-SA-01).

Table 5-1. SNL, California Site Waste Reduction Summary.

Waste Type	Waste Shipped in 1998 (kg)	Waste Shipped in 1999 (kg)	Change (%)
RCRA hazardous waste	21,624	26,505	+22.6
California regulated (non-RCRA) hazardous waste	39,943	20,567	-48.5
Low-level mixed waste	1,189	0	-100
Low-level radioactive waste	3,975	6,820	+71.6
TSCA (PCBs and asbestos)	10,434	23,901	+129
Biohazardous waste	296	248	-16.2
Sanitary waste	339,810	324,480	-4.5

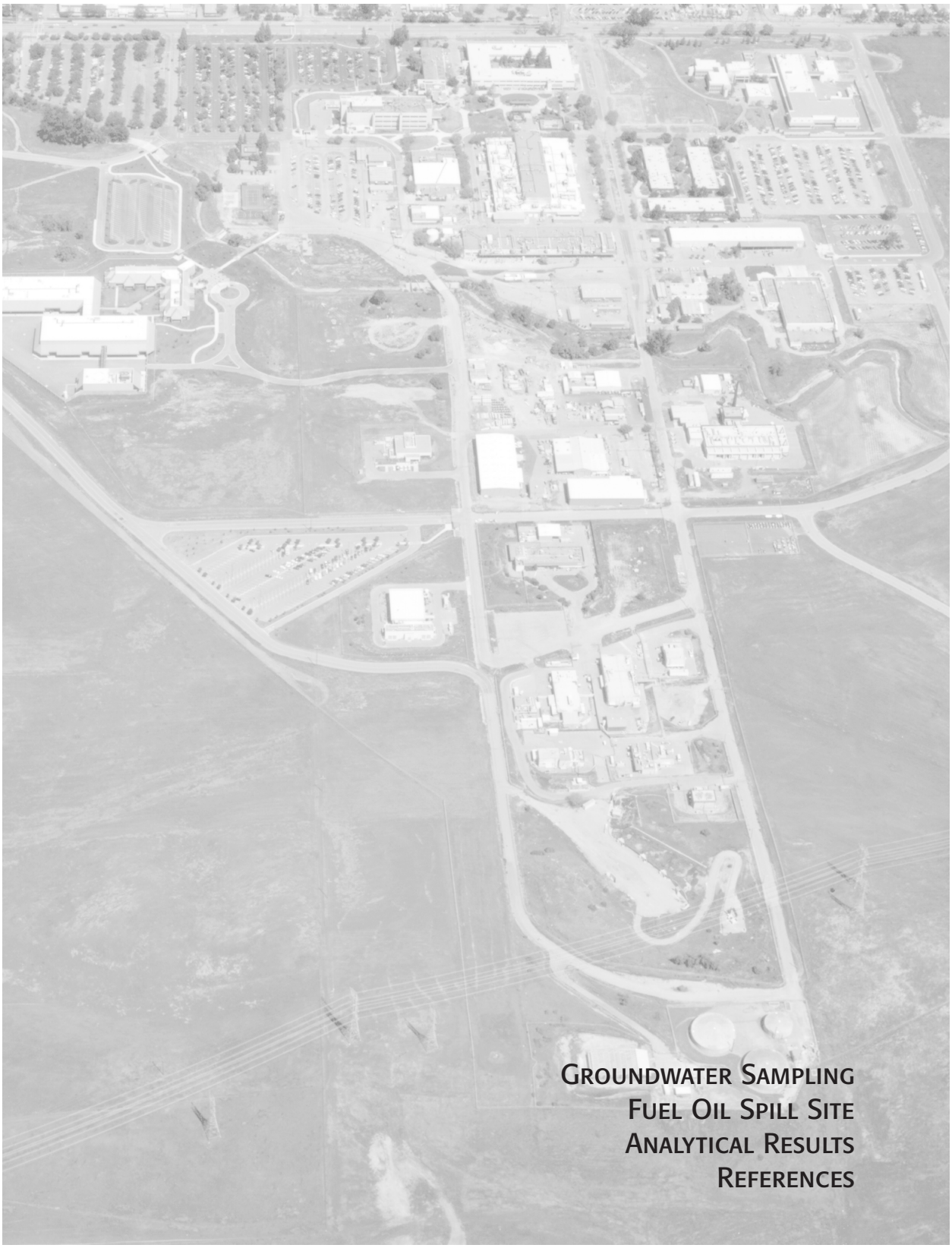
Table 5-2. SNL, California Site Recycling Activities (Estimated Values).

	Amount Recycled Per Year (in metric tons unless otherwise specified)					
Recycled Item	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Office Paper	26.50	44.79	35.21	23.79	22.44	32.98
Miscellaneous Paper					00.81	6.62
Cardboard			8.92	20.28	14.03	12.48
Toner Cartridges	0.72	1.22	0.66	1.94	1.74	0.46
Aluminum Cans	0.46	0.30	0.27	0.54	0.26	0.50
Tires		0.53	0.53	1.17	0.54	1.65
Scrap Metals[a]	91.00	68.04	90.78	77.70	116.60	14.42
Carpet Tiles						0.671
Transparencies						0.491
Construction Debris						13.83
Fluorescent Lights	6.54	4.54	0.40	2.00	0.68	2.60
Batteries	3.64	2.99	0.42	0.14	2.38	1.159
Oil	2.90	3.18	2.62	2.51	2.00	1.27
Coolant	5.44	4.26	4.98	1.51	0.13	0.09
Oil/Coolant						0.412
Laboratory Glass		20 cubic yd	0.55	0.54	0.13	0.23
Yard Waste (Disked into the soil)			NA	NA	NA	NA

Note: NA = data not available

[a]Scrap metals are not segregated or weighed. The weight indicated is an estimation.

6 — Groundwater



Sandia National Laboratories, California (SNL, California) issued the Groundwater Protection Management Program Plan in April 1999[1] to assure compliance with applicable Federal, State, and local environmental protection laws and regulations, Executive Orders, and internal department policies. The plan's objective is to document a management program for groundwater protection and remediation. Specifically, it addresses the Comprehensive Environmental Response Compensation and Liability Act, the Superfund Amendments and Reauthorization Act, the Resource Conservation and Recovery Act, and the Safe Drinking Water Act. The plan includes the following elements, as required by Department of Energy (DOE) Order 5400.1:[2]

- documentation of the quantity and quality of the groundwater,
- identification of sites that may be contaminated with hazardous substances, and
- a remedial action program, which is directed by the San Francisco Regional Water Quality Control Board (RWQCB) and contained in DOE directives.

SNL, California designed the Groundwater Monitoring Program as a part of the Environmental Restoration Program (see Chapter 5 for description of this program) to monitor the effectiveness of the site's pollution control measures and to make sure that contaminants are not entering domestic water supplies.

The groundwater sampling schedule calls for a subset of the monitoring wells to be sampled each quarter, as indicated in Table 6-1. This schedule was followed for 1999.

Parameters for analysis are selected in accordance with RWQCB requirements. The location of the wells are shown in Figure 6-1.

GROUNDWATER SAMPLING

Before sampling, the wells' suitability to be sampled was determined by checking water levels and conditions. If sampling was possible, the water was checked for pH, temperature, and specific conductivity before samples were taken. During 1998, SNL, California implemented micropurge sampling at a number of wells in order to reduce the amount of purged water generated. In addition, the sampling regimen was changed for the Arroyo Seco and Navy Landfill areas in accordance with guidance from the RWQCB. These changes are discussed below under their respective headings. Established quality assurance and quality control procedures were followed. These included chain of custody reporting and analyzing trip and equipment blanks to ensure the validity of the data. During the fourth quarter of 1999, SNL, California implemented zero-purge-sampling methodology at selected wells to further reduce the generation of contaminated purge water. This technology will be implemented at all wells not being sampled by micropurge methods during the 2000 sampling cycle.

Lawrence Livermore National Laboratory (LLNL) reports data from groundwater monitoring wells installed on SNL, California property as part of the LLNL groundwater investigation project. Results are reported in LLNL's *Monthly Progress Report*. The RWQCB requires quarterly reports to summarize groundwater-related project activities at SNL, California and are defined in Board Orders 88-142 and 89-184 and in memoranda from the RWQCB to the DOE.[3,4]

FUEL OIL SPILL SITE

The Fuel Oil Spill (FOS) site originally consisted of 17 monitoring wells. Seven wells (FM-1 through FM-7) were installed in 1984 to assess the impact of a 59,000-gallon diesel fuel spill on the subsurface environment. However, persistent

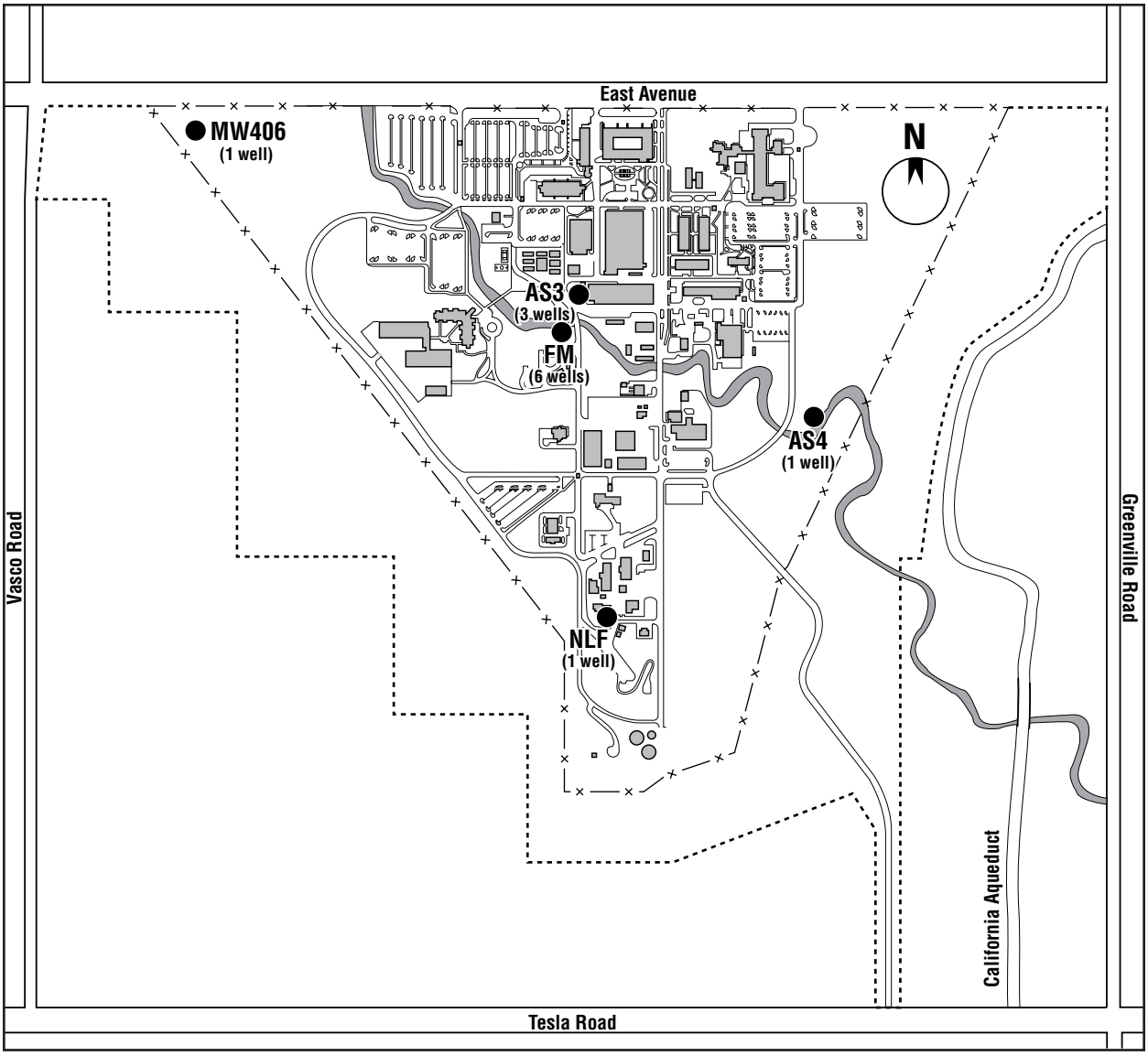


Figure 6-1. Groundwater monitoring well locations on the SNL, California site.

drought conditions lowered the water table, requiring the installation of ten deeper wells (FM-8 through FM-14, and FDG-1 through FDG-3) between 1986 and 1988.

During the third quarter of 1999, SNL, California received permission from the RWQCB to discontinue the bioremediation activities at the FOS site. In conjunction with this, the quarterly monitoring was reduced to six wells at the FOS site.

All 17 of the FOS monitoring wells had enough water for SNL, California to obtain a sample according to established procedures during the first two quarters of 1999. The six wells of the remaining at the FOS after dismantling the pilot bioremdiation system were sampled during the third and fourth quarters of 1999.

Arroyo Seco

In January 1986, four wells were installed at locations along the Arroyo Seco (AS-3

and AS-4 in Figure 6-1), which traverses the site. Locations of three of the wells (AS-3A, B, and C) were based on primary recharge areas and expected surface runoff points at the SNL, California site. Well AS-3C was installed at a much greater depth to monitor the third aquifer. (Water-bearing zones are numbered consecutively downward from the ground surface.) A fourth well, AS-4, installed upgradient of SNL, California was intended to function as a background well.

During the fourth quarter 1997, the sampling regimen for the Arroyo Seco wells was changed in accordance with RWQCB guidance. These wells are now sampled on an annual basis, during the second quarter. Annual sampling of wells AS-3A, AS-3B, AS-3C, and AS-4 was performed during the second quarter of 1999.

Navy Landfill

In January 1986, SNL, California installed one well (NLF-1) at the Navy Landfill (NLF) site, an abandoned landfill used in the 1940s and 1950s for construction debris. SNL, California installed three additional wells (NLF-2 through NLF-4) in June 1988 (Figure 6-1). In an effort to assess the elevated levels of chromium and nitrate observed in groundwater at the Navy Landfill site, SNL, California installed two additional monitoring wells (NLF-5 and NLF-6) in August 1993.

SNL, California received permission from the RWQCB to close the Navy Landfill in March of 1998. The closure activities included destruction of wells NLF-1, NLF-2, NLF-3, NLF-4, and NLF-5. Well NLF-6 remains on a quarterly sampling schedule, and was sampled during all four quarters of 1999.

Buffer Zone

In 1987, as part of the expansion of the DOE security buffer zone, DOE acquired property that had been used as a gasoline service station and an auto repair shop. This land, known as the Trudell Auto Repair site, had subsurface contamination from previous activities. Restoration of the Trudell site was completed in August 1990, and the RWQCB approved site closure in November 1990. Although cleanup of the site is officially complete, SNL, California continues to monitor the area through quarterly sampling of one well, MW-406 (see Figure 6-1). This well was installed by LLNL in 1988.

MW-406 was sampled during all four quarters of 1999.

Analytical Results

Comparison of groundwater constituents to maximum containment levels (MCLs) is provided for informational purposes only. The MCLs apply only to drinking water sources. None of the aquifers sampled are used as a source of drinking water.

In 1999, well NLF-6 was the only location in which carbon tetrachloride was detected. Carbon tetrachloride was detected during the second, third, and fourth quarters at levels greater than the State MCL (0.5 mg/L) at 1.1, 0.8, and 1.7 mg/L. SNL, California will continue to monitor for carbon tetrachloride.

Diesel was found in wells at the FOS site during all four quarterly sampling events. Diesel concentrations at the FOS site ranged from less than 50 µg/L to 290,000 µg/L. Figure 6-2 shows the highest diesel concentration in any FOS well from 1993 through 1999. Benzene concentrations above the state MCL (1 µg/L) were found in three of the FOS site wells during at least one quarter. Benzene concentrations above the state MCL ranged from 1.0 to 8.7 µg/L. The wells where benzene was found had high levels of diesel. Since benzene is a component of #2 diesel fuel oil, benzene can also be expected in these wells.

Monitoring well MW-406 showed Tetrachloroethene concentrations up to 2.8 µg/L. The state and federal MCLs are 5 µg/L, and were not exceeded.

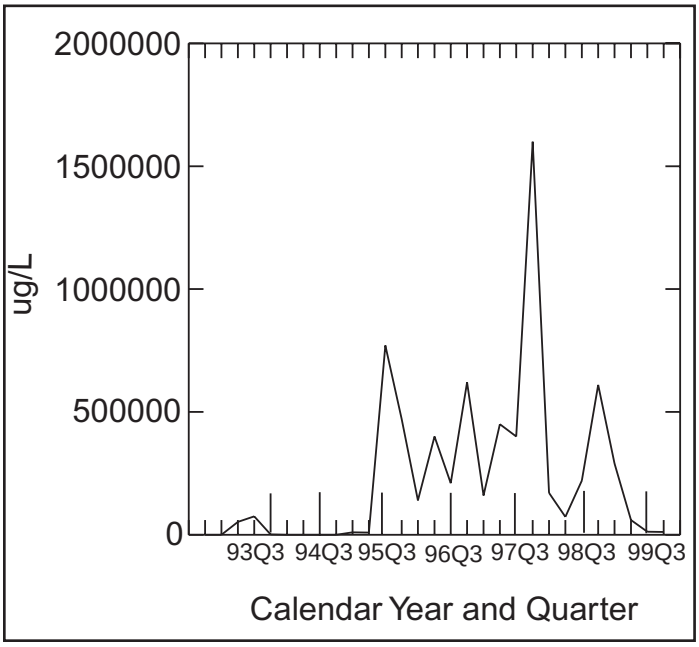


Figure 6-2. Highest diesel in any FOS well.

Groundwater from well MW-406 showed levels of iron, aluminum, magnesium, manganese, mercury, and nitrates (as nitrogen) above the MCLs for at least one quarter. Highest detected concentrations were 4.3, 3.9, 29, 0.09, 0.037, and 25 mg/L respectively (MCLs 0.3, 0.2, 0.05, 0.05, 0.002, and 10, respectively). The MCLs for iron, manganese, magnesium, and aluminum, are secondary MCLs.

Samples were analyzed during the second quarter 1999 for tritium,. The highest level of tritium detected was 532 pCi/L at well AS-3B.

For more details on analytical results, see Appendix A, Table A-4.

REFERENCES

1. U.S. DOE, Sandia National Laboratories, Livermore, *Groundwater Protection Management Program Plan* (April 1999).

2. U.S. DOE, Order 5400.1, *General Environmental Protection Program* (November 1988).

3. State of California, San Francisco Bay Region, Regional Water Quality Control Board, Order 88-142 (September 21, 1988).

4. State of California, San Francisco Bay Region, Regional Water Quality Control Board, Order 89-184 (December 13, 1989).

Table 6-1. Sample Analysis Schedule.

Area	Well ID	CCR Metals[a]	CCR General Minerals[b]	EPA 601	EPA 602/ BTEX	TPHD (8015)	RAD[c]	Water Elevation
Fuel Oil Spill	FM-1				Q	Q		Q
	FM-2				Q	Q		Q
	FM-3				Q	Q		Q
	FM-4				Q	Q		Q
	FM-5				Q	Q		Q
	FM-6				Q	Q		Q
	FM-7				Q	Q		Q
	FM-8				Q	Q		Q
	FM-9				Q	Q		Q
	FM-10				Q	Q		Q
	FM-11				Q	Q		Q
	FM-12				Q	Q		Q
	FM-13				Q	Q		Q
	FM-14				Q	Q		Q
	FDG-1				Q	Q		Q
	FDG-2				Q	Q		Q
	FDG-3				Q	Q		Q
Arroyo Seco	AS-3A	A	B	A		A	A	A
	AS-3B	A	B	A		A	A	A
	AS-3C	A	B	A		A	A	A
	AS-4	A	B	A		A	A	A
Navy Landfill	NLF-6	A	B	Q		A	A	A
Buffer Zone	MW-406	A	Q	Q	Q	Q	A	Q
	MW-11							Q

A=Annual (second quarter of each year)

B=Bi-annual (second quarter of alternate years)

Q=Quarterly

[a]CCR metals include antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, thallium, vanadium, and zinc.

[b]CCR general minerals include aluminum, bicarbonate, carbonate and hydroxide alkalinity, calcium, chloride, nitrate, fluoride salts, manganese, pH, sodium, specific conductance, and total dissolved solids, total hardness.

[c]RAD analysis includes tritium.

7 — Quality

Sandia National Laboratories (SNL, California) maintains an effluent monitoring and environmental surveillance program, as required by Department of Energy (DOE) Orders 5400.1 and 5400.5.[1,2] These Orders specify quality assurance requirements consistent with DOE Order 5700.6B.[3] The DOE has revised Order 5700.6B to 5700.6C.[4] The Outreach, Environment, Safety, and Health (ES&H), and Security Center at SNL, California has developed and is implementing a Quality Assurance Management Plan consistent with the provisions of DOE requirements.[5]

Consistent with the requirements of the *Quality Assurance Management Plan*, the Environmental Surveillance Program has developed a *Quality Assurance Project Plan*, which describes how the Quality Assurance Management Plan will be implemented.[6] To meet the most current guidance on quality assurance for environmental projects, the *Quality Assurance Project Plan* follows the guidance of DOE Implementation Guide G-830.120. Operating procedures supplement the Quality Assurance Project Plan and implementing provisions of the *Quality Assurance Management Plan*. Operating procedures specify requirements for environmental monitoring, Liquid Effluent Control System (LECS) monitoring, process wastewater sampling for compliance with Federal categorical pretreatment regulations, and sewer outfall sampling for compliance with the City of Livermore ordinance and Federal Clean Water Act regulations.

The Environmental Operations Department incorporates normal data and supervisory reviews into routine operations. SNL, California's upper management performs management assessments, as required in the Quality Assurance Management Plan. Assessments identify problems that may keep an organization from achieving required goals or conforming to requirements. Finally, the Quality Assurance Management Plan provides for independent technical assessments to verify quality.

DATA QUALITY ASSURANCE

SNL, California assesses the quality of the data collected for the Environmental Operations Department by estimating the precision and accuracy of the data. SNL, California estimates precision by collecting duplicate samples. The data obtained from the duplicate samples is compared to the data obtained from the routine samples. A confidence interval thereby can be calculated. The confidence interval represents the variability that exists in the monitoring system and the range of values around a reported data point, within which the actual value can be expected to lie.

Accuracy is estimated through analysis of samples containing a known amount of the constituent of interest. The result is compared to the known amount, and once again, a confidence interval is calculated. This confidence interval indicates the range of values within which the actual value can be expected to lie. In general, smaller confidence intervals represent more accurate and precise analyses.

The Environmental Operations Department has standardized methods for calculating confidence intervals and has established acceptance criteria for them. These methods and acceptance criteria are described in the procedure, *Data Validation and Verification for the Environmental Monitoring Program*.[7] The acceptance criteria account for the confidence interval enlarging (i.e., the error associated with the analysis becomes greater) as the concentration of a constituent in a sample approaches the detection limit. For this reason, acceptance criteria that may be achievable at relatively high concentrations may not be achievable at very low concentrations. At very low levels, the presence of the constituent of interest may be detected, but

not the quantity. To address this phenomenon, the Environmental Protection Agency (EPA) recommends that "practical quantitation limits" be established. The Environmental Operations Department has established practical quantitation limits at ten times the detection limit for each constituent of interest. Therefore, the acceptance limits for precision and accuracy are progressive—the confidence interval can be larger near the detection limit and smaller as the practical quantitation limit is approached.

To facilitate the calculation of confidence intervals for accuracy and precision, the procedures for collecting environmental samples specify three types of quality control samples:

- *Duplicate Samples.* Duplicate samples are collected according to the same methods as the routine samples, and at the same time and location. These samples are used to assess the precision (repeatability) of the sample collection and analysis system.
- *Spiked Samples.* These samples resemble the routine samples collected, but contain a known amount of one or more of the constituents of interest. These samples are obtained from an independent laboratory that certifies the concentration of the included constituents.
- *Blank Samples.* Blank samples resemble the routine samples as closely as possible, but lack the constituent of interest. These samples are not used to assess accuracy or precision, but are important for assessing possible contamination of the samples during collection, transportation, and analysis.

Table 7-1 presents data from SNL, California's duplicate sampling. These data represent the precision of the combined sampling and analytical processes. All t-tests between routine and duplicate samples showed no significant difference at the 95% confidence level. However, the t-test for total dissolved solids, and biochemical oxygen demand do show a significant difference at the 90%confidence level. However, the 95% confidence intervals for chemical oxygen demand, and total suspended solids in wastewater do not meet the acceptance criteria of having a width of less than 50% of the routine sample average. An investigation into these phenomena indicates that the most probable reason for the discrepancies is the extraordinary heterogeneity of the wastewater samples. Care is taken when collecting duplicate samples, so the differences noted are taken to reflect the true variable nature of the wastewater. The ratios of duplicate to routine samples for iron and aluminum in storm water also do not meet the acceptance criteria, indicating the variable nature of the storm water.

DATA INTERPRETATION

Once the precision and accuracy of the data have been established, and the acceptance criteria have been met, the data must be interpreted. Data Analysis for the Environmental Monitoring Program describes SNL, California's methods for interpreting data.[8] These methods fall into several categories:

- *Determining averages and standard deviations*. Averages and standard deviations are useful as summaries of data collected during the year. The usual methods for calculating averages and standard deviations assume that the data have a "normal" (bell curve) distribution. However, many environmental data do not follow a normal distribution, and the usual methods of calculating averages and standard deviations would be misleading for these data sets. Therefore, all data sets are tested for normality. If the data are found to be not normally distributed, then the average and standard deviation appropriate for a data set with a lognormal distribution are calculated. (Most environ-

mental data follow a lognormal distribution if they are not distributed normally.) Data sets with ten or fewer data points are treated as normally distributed, with no checks of the distribution, because more data points are needed to describe the distribution accurately.

- *Testing for outliers.* SNL, California includes outlying data in the data sets, unless they can be attributed to a specific cause (such as laboratory contamination of the sample). SNL, California personnel use box plots (a statistical method) to determine outliers.
- *Comparing data.* If possible, SNL, California personnel compare data collected on or near the SNL, California site and data collected at "background"—or distant—locations. If concentrations on or near the site are observed at a higher concentration than at distant locations, the site may be assumed to be the source of observed hazardous or radioactive materials in the environment. Conversely, if concentrations on or near the site are similar to (or lower than) concentrations at distant locations, the site may be assumed not to be the source of hazardous or radioactive materials in the environment. SNL, California personnel compare concentrations by using t-tests (statistical tests) or by analysis of variance techniques to determine if any observed differences are statistically significant.
- *Determining compliance with standards.* If regulatory standards have been established for hazardous or radioactive material concentrations in an environmental medium, SNL, California compares monitoring results to the standard. Because a single data point is associated with high uncertainty, SNL, California personnel use the confidence interval for precision, as calculated above, for comparison. If the 95% confidence interval around the observed value includes values at or above the regulatory standard, then the standard may have been exceeded. The data are investigated further to confirm, if possible, whether or not the standard was indeed exceeded. If the entire confidence interval is above the regulatory limit, then we assume the standard was exceeded.
- *Determining values below the analytical detection limit.* Most analytical methods cannot state definitively that the concentration of a hazardous or radioactive material is zero. Most analytical methods have a "lower limit of detection," below which material presence cannot be ascertained. This lower detection limit usually is defined as the concentration at which the presence of the material can be detected with 99% statistical certainty. These values are shown with a "less than" symbol (<) preceding the value. They cannot be used in the normal statistical calculations described above because they represent ranges instead of discrete values. To perform statistical calculations on data sets containing these values, SNL, California personnel use the following methods:
  - If more than one-third of the data set consists of detection limit values, SNL, California reports the median and median absolute deviation of the data set, instead of the average and standard deviation.
  - If less than one-third of the data set consists of detection limit values, SNL, California calculates averages and stan-

dard deviations using the detection limit as a normal result. (This method is conservative because it really represents the highest possible value for the data.)

REFERENCES

1. U.S. DOE, Order 5400.1, *General Environmental Protection Program* (November 1988).

2. U.S. DOE, Order 5400.5, *Radiation Protection of the Public and the Environment* (February 8, 1990) (Change 2, January 7, 1993).

3. U.S. DOE, Order 5700.6B, *Quality Assurance* (March 1989).

4. U.S. DOE, Order 5700.6C, *Quality Assurance* (August 21, 1991) (Change 1, May 10, 1996).

5. U.S. DOE, Sandia National Laboratories/California, *Quality Assurance Management Plan* (1991).

6. R. C. Holland, *Environmental Monitoring Program Quality Assurance Project Plan*, Sandia National Laboratories/California, SAND93-8010 (June 1993).

7. U.S. DOE, Sandia National Laboratories/California, *Data Validation and Verification for the Environmental Monitoring Program* (January 1994).

8. U.S. DOE, Sandia National Laboratories/California, *Data Analysis for the Environmental Monitoring Program* (January 1994).

Table 7-1. Quality Assurance—Duplicate Sampling, Selected Parameters on SNL, California Collected Samples.

Medium	Analysis	Confidence Interval (95%)[a]	Ratio[b]
Wastewater			
	Biological oxygen demand	-3.7/41.8	—[d]
	Chemical oxygen demand	-25.4/62.7	—[d]
	Total suspended solids	-36.1/113.3	—[d]
	Total dissolved solids	-1.5/12.9	—[d]
	Specific conductivity	-3.1/2.5	—[d]
	Copper	-5.6/12.9	—[d]
	Zinc	-8.0/15.8	—[d]
	Chloroform	-11.3/8.4	—[d]
Storm Water Runoff			
	pH	—[c]	1.00
	Specific conductivity	—[c]	1.14
	Total suspended solids	—[c]	1.00
	Zinc		1.14
	Iron		1.48
	Aluminum		1.58

[a]Only calculated for data sets with more than eight valid data pairs.

[b]Only calculated for data sets with less than eight valid data pairs. The value is the ratio of quality assurance sample/routine sample.

[c]Not calculated—less than eight valid data pairs available.

[d]Not calculated—more than eight valid data pairs available.

ACRONYMS AND ABBREVIATIONS
TECHNICAL TERMS
RADIOLOGICAL UNITS

ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
BAAQMD	Bay Area Quality Management District
BOD	biological oxygen demand
BTEX	benzene, toluene, ethylbenzene, xylenes
CAA	Clean Air Act (Federal)
Cal/EPA	California Environmental Protection Agency
CEQA	California Environmental Quality Act
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CN	cyanide
COD	chemical oxygen demand
CWA	Clean Water Act (Federal)
DOE	Department of Energy
EDE	effective dose equivalent
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ES&H	environment, safety, and health
FOS	Fuel Oil Spill
IDT	Interdisciplinary Team
ISMS	Integrated Safety Management System
KAO	Kirtland Area Office
LECS	Liquid Effluent Control System
LLNL	Lawrence Livermore National Laboratory
LWRP	Livermore Water Reclamation Plant
MBTA	Migratory Bird Treaty Act
MSDS	Material Safety Data Sheet
NEPA	National Enviornmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NLF	Navy Landfill
NPDES	National Pollutant Discharge Elimination System
O&G	oil and grease
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act

SCEC	Sandia, California ES&H Council
SI	International System of Units
SNL	Sandia National Laboratories
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
TPH	Total Petroleum Hydrocarbons
TRI	Toxic Release Inventory
TSCA	Toxic Substance Control Act
TSS	total suspended solids
TTO	total toxic organic

TECHNICAL TERMS

accuracy	The closeness of the result of a measurement to the true value of the quantity measured.
aliquot	A portion of a sample taken for analysis.
ambient air	The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. It does not include the air next to emission sources.
aquifer	A saturated layer of rock or soil below the ground surface that can supply usable quantities of ground water to wells and springs. Aquifers can be a source of water for domestic, agricultural, and industrial uses.
arroyo	An intermittent or seasonal stream.
background radiation	Ionizing radiation from natural sources. It may include cosmic radiation; external radiation from naturally occurring radioactivity in the earth (terrestrial radiation), air, and water; internal radiation from naturally occurring radioactive elements in the human body; and radiation from medical diagnostic procedures.
best management practice	Any method, process, or procedure developed to prevent and/or reduce pollutants discharged to the environment.
categorical process	An industrial process, which discharges wastewater and is regulated under Title 40 CFR, Part 403.
contaminant	Any hazardous or radioactive material present in an environmental medium, such as water or vegetation.
controlled area	Any Laboratory area to which access is controlled to protect individuals from exposure to radiation and radioactive materials.
discharge	A release into an area not controlled by SNL, California.
dose	A term denoting the quantity of radiation energy absorbed.
dosimeter	A portable detection device for measuring the total accumulated exposure to ionizing radiation. See also *thermoluminescent dosimeter*.

downgradient	In the direction of groundwater flow from a designated area of interest; analogous to downstream.
effluent	A liquid or gaseous waste discharged to the environment.
emission	A gaseous or liquid stream containing one or more contaminants. The verb form, emit, means the act of discharging a contaminant or pollutant into the environment.
environmental remediation	The process of restoring a contaminated area to a noncontaminated or safe condition.
external radiation	Radiation originating from a source outside the body.
extractable pollutants	Pollutants that can be removed from a contaminated sample by passing water through the sample.
groundwater	A subsurface body of water in the zone of saturation (where soil sediments have become saturated with water).
hazardous waste	Waste exhibiting any of the following characteristics: ignitability, corrosivity, reactivity, or EP-toxicity (yielding toxic constituents in a leaching test). Because of its concentration, quantity, physical, or chemical characteristics, it may: 1) cause or significantly contribute to an increase in mortality rates or cases of serious irreversible illness; or 2) pose a substantial present or potential threat to human health or the environment when improperly treated, stored, transported, disposed of, or handled.
nonattainment area	An area that does not meet the National Ambient Air Quality Standards.
non-storm water	Any water flow that is not entirely composed of rain.
organic compound	A chemical whose primary constituents are carbon and hydrogen.
organochloride	An organic compound in which one or more of the hydrogen atoms have been replaced with a chlorine atom.
Part B permit	The second, narrative section submitted by hazardous waste generators in the RCRA permitting process. It details the procedures followed at a facility to protect human health and the environment.
pH	A measure of hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH less than 7, basic solutions have a pH greater than 7, and neutral solutions have a pH of 7.
pollutant	Any hazardous or radioactive material present in an environmental medium, such as water or vegetation. For storm water, a pollutant is a material that can be mobilized in water, including (but not limited to) litter, soil, oil and grease, pesticides, and fertilizer.
pretreatment	Any process used to reduce a pollutant load before wastewater enters the sewer system.

pretreatment regulations National wastewater pretreatment regulations (Title 40 CFR, Part 403) adopted by the EPA in compliance with the 1977 amendments to the Clean Water Act, which required that the EPA establish pretreatment standards for existing and new industrial sources.

priority pollutants A set of organic and inorganic chemicals identified by the EPA as indicators of environmental contamination.

purgeable pollutants Pollutants that can be removed from a sample by passing nitrogen gas through the sample.

radiation Energy emitted from the nucleus of an atom in the form of waves or particles.

radioactivity The property or characteristic of a nucleus of an atom to spontaneously disintegrate accompanied by the emission of energy in the form of radiation.

recharge zone An area of the ground in which surface water migrates to the groundwater.

remediation See *environmental remediation*.

sanitary sewer system A system that collects or conveys domestic and industrial wastewater off site. The SNL/California system connects to the LLNL sanitary sewer system, and the combined effluent then connects to the City of Livermore municipal sewer system. The effluent is treated at the Livermore Water Reclamation Plant.

scintillation cocktail A solution of organic compounds that emits light upon interacting with radiation. For the purposes of this report, it is used primarily for the tritium analysis.

source Any operation or equipment that produces and/or emits pollutants (e.g., pipe, ditch, well, or stack).

storm drain system A collection of inlets, catch basins, channels, and trenches, which transport rain from paved areas on the SNL/California site to the Arroyo Seco.

storm water runoff Rainfall on paved areas that flows over the ground surface.

thermoluminescent dosimeter A type of dosimeter. After being exposed to radiation, the material in the dosimeter (lithium fluoride) luminesces upon being heated. The amount of light the material emits is proportional to the amount of radiation (dose) to which it was exposed. See also dosimeter.

tritium A radionuclide of hydrogen with a half-life of 12.3 years. The very low energy of its radioactivity decay makes it one of the least hazardous radionuclides.

uncontrolled area An area beyond the boundaries of a controlled area. See *controlled area*.

upgradient Opposite of the direction of groundwater flow from a designated area of interest. Analogous to upstream.

Zone 7 The common name for the Alameda County Flood Control and Water Conservation District. Zone 7 is the water management agency for the Livermore-Amador Valley with responsibility for water treatment and distribution. Zone 7 is also responsible for management of agricultural and surface water and the groundwater basin.

RADIOLOGICAL UNITS

becquerel (Bq) Unit of radioactive decay equal to one disintegration per second. (SI unit)

curie (Ci) Unit of radioactive decay equal to 2.22×10^{12} disintegrations per minute. (conventional unit)

millirem (mrem) Unit equal to 10^{-3} rem. See *rem*.

rem Stands for roentgen equivalent man; a unit of ionizing radiation, equal to the amount of radiation needed to produce the same biological effect to humans as 1 rad of high-voltage x-rays. It is the product of the absorbed dose (rad), quality factor (Q), distribution factor, and other necessary modifying factors. It describes the effectiveness of various types of radiation in producing biological effects.

Appendix A — Data Tables

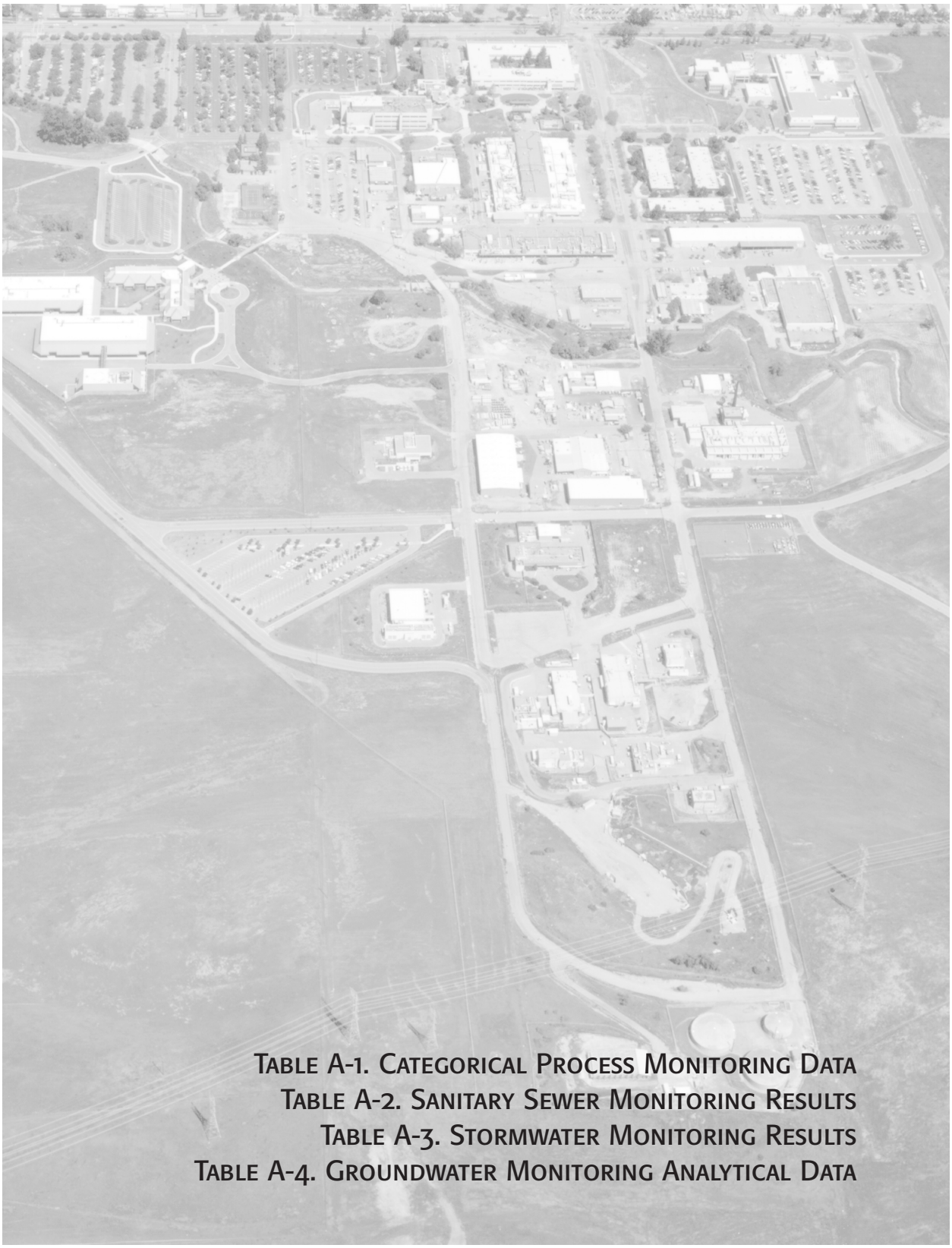


Table A-1. Categorical Process Monitoring Data.

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max	Regulatory Limit
968/120								
Dioxins and Furans								1.37[a]
Dibenzofuran	µg/L	7	100.0%	0.000	0.000	ND	ND	
Inorganic Parameters								
pH	s.u.	7	0.0%	8.070	7.680	7.200	9.310	
Metals								
Arsenic	mg/L	7	100.0%	0.000	0.000	ND	ND	2.09
Semi-volatile Organic Compounds								1.37[a]
1,3-Dichlorobenzidine	µg/L	2	100.0%	0.000	0.000	ND	ND	
2,4,5-Trichlorophenol	µg/L	2	100.0%	0.000	0.000	ND	ND	
2,4,6-Trichlorophenol	µg/L	7	100.0%	0.000	0.000	ND	ND	
2,4-Dichlorophenol	µg/L	7	100.0%	0.000	0.000	ND	ND	
2,4-Dimethylphenol	µg/L	7	100.0%	0.000	0.000	ND	ND	
2,4-Dinitrophenol	µg/L	7	100.0%	0.000	0.000	ND	ND	
2,4-Dinitrotoluene	µg/L	7	100.0%	0.000	0.000	ND	ND	
2,6-Dinitrotoluene	µg/L	7	100.0%	0.000	0.000	ND	ND	
2-Chloronaphthalene	µg/L	7	100.0%	0.000	0.000	ND	ND	
2-Chlorophenol	µg/L	7	100.0%	0.000	0.000	ND	ND	
2-Methyl-4,6-dinitrophenol	µg/L	5	100.0%	0.000	0.000	ND	ND	
2-Methylnaphthalene	µg/L	2	100.0%	0.000	0.000	ND	ND	
2-Methylphenol	µg/L	2	100.0%	0.000	0.000	ND	ND	
2-Nitroaniline	µg/L	2	100.0%	0.000	0.000	ND	ND	
2-Nitrophenol	µg/L	7	100.0%	0.000	0.000	ND	ND	
3,3'-Dichlorobenzidine	µg/L	5	100.0%	0.000	0.000	ND	ND	
3-Nitroaniline	µg/L	2	100.0%	0.000	0.000	ND	ND	
4,6-Dinitro-2-methylphenol	µg/L	2	100.0%	0.000	0.000	ND	ND	
4-Bromophenyl phenyl ether	µg/L	7	100.0%	0.000	0.000	ND	ND	
4-Chloro-3-methylphenol	µg/L	7	100.0%	0.000	0.000	ND	ND	
4-Chloroaniline	µg/L	2	100.0%	0.000	0.000	ND	ND	
4-Chlorophenyl phenylether	µg/L	7	100.0%	0.000	0.000	ND	ND	
4-Methylphenol	µg/L	2	100.0%	0.000	0.000	ND	ND	
4-Nitroaniline	µg/L	2	100.0%	0.000	0.000	ND	ND	
4-Nitrophenol	µg/L	7	100.0%	0.000	0.000	ND	ND	
Acenaphthene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Acenaphthylene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Anthracene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Benzidine	µg/L	5	100.0%	0.000	0.000	ND	ND	
Benzo(a)anthracene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Benzo(a)pyrene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Benzo(b)fluoranthene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Benzo(ghi)perylene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Benzo(k)fluoranthene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Benzoic acid	µg/L	2	100.0%	0.000	0.000	ND	ND	
Benzyl butyl phthalate	µg/L	3	100.0%	0.000	0.000	ND	ND	
bis(2-chloroethoxy) methane	µg/L	7	100.0%	0.000	0.000	ND	ND	
bis(2-chloroethyl) ether	µg/L	7	100.0%	0.000	0.000	ND	ND	
bis(2-chloroisopropyl) ether	µg/L	7	100.0%	0.000	0.000	ND	ND	

Table A-1. Categorical Process Monitoring Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max	Regulatory Limit
bis(2-Ethylhexyl) phthalate	µg/L	7	100.0%	0.000	0.000	ND	ND	
Butyl benzyl phthalate	µg/L	4	100.0%	0.000	0.000	ND	ND	
Chrysene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Di-n-butyl phthalate	µg/L	7	100.0%	0.000	0.000	ND	ND	
Di-n-octyl phthalate	µg/L	7	100.0%	0.000	0.000	ND	ND	
Dibenzo(a,h)anthracene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Diethyl phthalate	µg/L	7	100.0%	0.000	0.000	ND	ND	
Dimethyl phthalate	µg/L	7	100.0%	0.000	0.000	ND	ND	
Fluoranthene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Fluorene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Hexachlorobenzene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Hexachlorobutadiene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Hexachlorocyclopentadiene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Hexachloroethane	µg/L	7	100.0%	0.000	0.000	ND	ND	
Indeno(1,2,3-cd)pyrene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Isophorone	µg/L	7	100.0%	0.000	0.000	ND	ND	
N-Nitroso-Di-n-propylamine	µg/L	7	100.0%	0.000	0.000	ND	ND	
N-Nitrosodimethylamine	µg/L	2	100.0%	0.000	0.000	ND	ND	
N-nitrosodiphenylamine	µg/L	7	100.0%	0.000	0.000	ND	ND	
Naphthalene	µg/L	9	100.0%	0.000	0.000	ND	ND	
Nitrobenzene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Pentachlorophenol	µg/L	7	100.0%	0.000	0.000	ND	ND	
Phenanthrene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Phenol	µg/L	7	100.0%	0.000	0.000	ND	ND	
Pyrene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Volatile Organic Compounds								1.37[a]
1,1,1,2-Tetrachloroethane	µg/L	2	100.0%	0.000	0.000	ND	ND	
1,1,1-Trichloroethane	µg/L	7	100.0%	0.000	0.000	ND	ND	
1,1,2,2-Tetrachloroethane	µg/L	7	100.0%	0.000	0.000	ND	ND	
1,1,2-Trichloroethane	µg/L	7	100.0%	0.000	0.000	ND	ND	
1,1-Dichloroethane	µg/L	7	100.0%	0.000	0.000	ND	ND	
1,1-Dichloroethene	µg/L	7	100.0%	0.000	0.000	ND	ND	
1,2,4-Trichlorobenzene	µg/L	7	100.0%	0.000	0.000	ND	ND	
1,2-Dibromo-3-chloropropane	µg/L	2	100.0%	0.000	0.000	ND	ND	
1,2-Dibromoethane	µg/L	2	100.0%	0.000	0.000	ND	ND	
1,2-Dichlorobenzene	µg/L	14	100.0%	0.000	0.000	ND	ND	
1,2-Dichloroethane	µg/L	7	100.0%	0.000	0.000	ND	ND	
1,2-Dichloroethene	(Total)	µg/L	3	100.0%	0.000	0.000	ND	
1,2-Dichloropropane	µg/L	7	100.0%	0.000	0.000	ND	ND	
1,3-Dichlorobenzene	µg/L	14	100.0%	0.000	0.000	ND	ND	
1,4-Dichlorobenzene	µg/L	14	100.0%	0.000	0.000	ND	ND	
2-Chloroethyl vinyl ether	µg/L	2	100.0%	0.000	0.000	ND	ND	
2-Hexanone	µg/L	2	100.0%	0.000	0.000	ND	ND	
2-Butanone(MEK)	µg/L	2	100.0%	0.000	0.000	ND	ND	
4-Methyl-2-pentanone	(MIBK)	µg/L	2	100.0%	0.000	0.000	ND	
Acetone	µg/L	2	50.0%	7000.000	7000.000	ND	14000.000	
Benzene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Benzyl alcohol	µg/L	2	100.0%	0.000	0.000	ND	ND	
Bromobenzene	µg/L	2	100.0%	0.000	0.000	ND	ND	
Bromochloromethane	µg/L	2	100.0%	0.000	0.000	ND	ND	

Table A-1. Categorical Process Monitoring Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max	Regulatory Limit
Bromodichloromethane	µg/L	7	100.0%	0.000	0.000	ND	ND	
Bromoform	µg/L	7	100.0%	0.000	0.000	ND	ND	
Bromomethane	µg/L	7	100.0%	0.000	0.000	ND	ND	
Carbon disulfide	µg/L	2	100.0%	0.000	0.000	ND	ND	
Carbon tetrachloride	µg/L	7	100.0%	0.000	0.000	ND	ND	
Chlorobenzene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Chloroethane	µg/L	7	100.0%	0.000	0.000	ND	ND	
Chloroform	µg/L	7	100.0%	0.000	0.000	ND	ND	
Chloromethane	µg/L	7	100.0%	0.000	0.000	ND	ND	
cis-1,2-Dichloroethene	µg/L	7	100.0%	0.000	0.000	ND	ND	
cis-1,3-Dichloropropene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Dibromochloromethane	µg/L	7	100.0%	0.000	0.000	ND	ND	
Dibromomethane	µg/L	2	100.0%	0.000	0.000	ND	ND	
Dichlorodifluoromethane	µg/L	2	100.0%	0.000	0.000	ND	ND	
Ethyl benzene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Freon 113	µg/L	5	100.0%	0.000	0.000	ND	ND	
Isopropyl benzene	µg/L	2	100.0%	0.000	0.000	ND	ND	
Methylene chloride	µg/L	7	100.0%	0.000	0.000	ND	ND	
o-Xylene	µg/L	5	100.0%	0.000	0.000	ND	ND	
p,m-Xylenes	µg/L	4	100.0%	0.000	0.000	ND	ND	
Styrene	µg/L	2	100.0%	0.000	0.000	ND	ND	
Tetrachloroethene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Toluene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Total Xylenes	µg/L	5	100.0%	0.000	0.000	ND	ND	
trans-1,2-Dichloroethene	µg/L	7	100.0%	0.000	0.000	ND	ND	
trans-1,3-Dichloropropene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Trichloroethene	µg/L	7	100.0%	0.000	0.000	ND	ND	
Trichlorofluoromethane	µg/L	7	100.0%	0.000	0.000	ND	ND	
Trichlorotrifluoromethane	µg/L	2	100.0%	0.000	0.000	ND	ND	
Vinyl acetate	µg/L	2	100.0%	0.000	0.000	ND	ND	
Vinyl chloride	µg/L	7	100.0%	0.000	0.000	ND	ND	
910 LEC								
Dioxins and Furans								1.37[a]
Dibenzofuran	µg/L	4	100.0%	0.000	0.000	ND	ND	
Inorganic Parameters								
pH	s.u.	3	0.0%	7.060	6.900	6.800	7.480	
Total cyanide	mg/L	1	100.0%	0.000	0.000	ND	ND	
Metals								
Arsenic	mg/L	3	100.0%	0.000	0.000	ND	ND	N/A
Cadmium	mg/L	3	100.0%	0.000	0.000	ND	ND	0.69
Chromium	mg/L	3	0.0%	0.113	0.100	0.050	0.190	2.77
Copper	mg/L	4	0.0%	0.570	0.260	0.059	1.700	3.38
Lead	mg/L	3	33.3%	0.022	0.006	ND	0.060	0.69
Mercury	mg/L	3	66.7%	0.000	0.000	ND	0.001	N/A
Nickel	mg/L	3	100.0%	0.000	0.000	ND	ND	3.98
Silver	mg/L	3	100.0%	0.000	0.000	ND	ND	0.43
Zinc	mg/L	3	0.0%	0.017	0.020	0.011	0.020	2.61
Semi-volatile Organic Compounds								2.13[a]
1,3-Dichlorobenzidine	µg/L	1	100.0%	0.000	0.000	ND	ND	

Table A-1. Categorical Process Monitoring Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max	Regulatory Limit
2,4,5-Trichlorophenol	µg/L	1	100.0%	0.000	0.000	ND	ND	
2,4,6-Trichlorophenol	µg/L	4	100.0%	0.000	0.000	ND	ND	
2,4-Dichlorophenol	µg/L	4	100.0%	0.000	0.000	ND	ND	
2,4-Dimethylphenol	µg/L	4	100.0%	0.000	0.000	ND	ND	
2,4-Dinitrophenol	µg/L	4	100.0%	0.000	0.000	ND	ND	
2,4-Dinitrotoluene	µg/L	4	100.0%	0.000	0.000	ND	ND	
2,6-Dinitrotoluene	µg/L	4	100.0%	0.000	0.000	ND	ND	
2-Chloronaphthalene	µg/L	4	100.0%	0.000	0.000	ND	ND	
2-Chlorophenol	µg/L	4	100.0%	0.000	0.000	ND	ND	
2-Methyl-4,6-dinitrophenol	µg/L	3	100.0%	0.000	0.000	ND	ND	
2-Methylnaphthalene	µg/L	1	100.0%	0.000	0.000	ND	ND	
2-Methylphenol	µg/L	1	100.0%	0.000	0.000	ND	ND	
2-Nitroaniline	µg/L	1	100.0%	0.000	0.000	ND	ND	
2-Nitrophenol	µg/L	4	100.0%	0.000	0.000	ND	ND	
3,3'-Dichlorobenzidine	µg/L	3	100.0%	0.000	0.000	ND	ND	
3-Nitroaniline	µg/L	1	100.0%	0.000	0.000	ND	ND	
4,6-Dinitro-2-methylphenol	µg/L	1	100.0%	0.000	0.000	ND	ND	
4-Bromophenyl phenyl ether	µg/L	4	100.0%	0.000	0.000	ND	ND	
4-Chloro-3-methylphenol	µg/L	4	100.0%	0.000	0.000	ND	ND	
4-Chloroaniline	µg/L	1	100.0%	0.000	0.000	ND	ND	
4-Chlorophenyl phenyl ether	µg/L	4	100.0%	0.000	0.000	ND	ND	
4-Methylphenol	µg/L	1	100.0%	0.000	0.000	ND	ND	
4-Nitroaniline	µg/L	1	100.0%	0.000	0.000	ND	ND	
4-Nitrophenol	µg/L	4	100.0%	0.000	0.000	ND	ND	
Acenaphthene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Acenaphthylene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Anthracene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Benzidine	µg/L	3	100.0%	0.000	0.000	ND	ND	
Benzo(a)anthracene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Benzo(a)pyrene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Benzo(b)fluoranthene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Benzo(ghi)perylene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Benzo(k)fluoranthene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Benzoic acid	µg/L	1	100.0%	0.000	0.000	ND	ND	
Benzyl butyl phthalate	µg/L	2	100.0%	0.000	0.000	ND	ND	
bis(2-chloroethoxy) methane	µg/L	4	100.0%	0.000	0.000	ND	ND	
bis(2-chloroethyl) ether	µg/L	4	100.0%	0.000	0.000	ND	ND	
bis(2-chloroisopropyl) ether	µg/L	4	100.0%	0.000	0.000	ND	ND	
bis(2-Ethylhexyl) phthalate	µg/L	4	100.0%	0.000	0.000	ND	ND	
Butyl benzyl phthalate	µg/L	2	100.0%	0.000	0.000	ND	ND	
Chrysene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Di-n-butyl phthalate	µg/L	4	100.0%	0.000	0.000	ND	ND	
Di-n-octyl phthalate	µg/L	4	100.0%	0.000	0.000	ND	ND	
Dibenzo(a,h)anthracene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Diethyl phthalate	µg/L	4	100.0%	0.000	0.000	ND	ND	
Dimethyl phthalate	µg/L	4	100.0%	0.000	0.000	ND	ND	
Fluoranthene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Fluorene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Hexachlorobenzene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Hexachlorobutadiene	µg/L	4	100.0%	0.000	0.000	ND	ND	

Table A-1. Categorical Process Monitoring Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max	Regulatory Limit
Hexachlorocyclopentadiene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Hexachloroethane	µg/L	4	100.0%	0.000	0.000	ND	ND	
Indeno(1,2,3-cd)pyrene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Isophorone	µg/L	4	100.0%	0.000	0.000	ND	ND	
N-Nitroso-Di-n-propylamine	µg/L	4	100.0%	0.000	0.000	ND	ND	
N-Nitrosodimethylamine	µg/L	1	100.0%	0.000	0.000	ND	ND	
N-nitrosodiphenylamine	µg/L	4	100.0%	0.000	0.000	ND	ND	
Naphthalene	µg/L	5	100.0%	0.000	0.000	ND	ND	
Nitrobenzene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Pentachlorophenol	µg/L	4	100.0%	0.000	0.000	ND	ND	
Phenanthrene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Phenol	µg/L	4	100.0%	0.000	0.000	ND	ND	
Pyrene	µg/L	4	100.0%	0.000	0.000	ND	ND	
Volatile Organic Compounds								2.13[a]
1,1,1,2-Tetrachloroethane	µg/L	1	100.0%	0.000	0.000	ND	ND	
1,1,1-Trichloroethane	µg/L	3	100.0%	0.000	0.000	ND	ND	
1,1,2,2-Tetrachloroethane	µg/L	3	100.0%	0.000	0.000	ND	ND	
1,1,2-Trichloroethane	µg/L	3	100.0%	0.000	0.000	ND	ND	
1,1-Dichloroethane	µg/L	3	100.0%	0.000	0.000	ND	ND	
1,1-Dichloroethene	µg/L	3	100.0%	0.000	0.000	ND	ND	
1,2,4-Trichlorobenzene	µg/L	4	100.0%	0.000	0.000	ND	ND	
1,2-Dibromo-3-chloropropane	µg/L	1	100.0%	0.000	0.000	ND	ND	
1,2-Dibromoethane	µg/L	1	100.0%	0.000	0.000	ND	ND	
1,2-Dichlorobenzene	µg/L	7	100.0%	0.000	0.000	ND	ND	
1,2-Dichloroethane	µg/L	3	100.0%	0.000	0.000	ND	ND	
1,2-Dichloroethene	(Total)	µg/L	1	100.0%	0.000	NaN	ND	
1,2-Dichloropropane	µg/L	3	100.0%	0.000	0.000	ND	ND	
1,3-Dichlorobenzene	µg/L	7	100.0%	0.000	0.000	ND	ND	
1,4-Dichlorobenzene	µg/L	7	100.0%	0.000	0.000	ND	ND	
2-Butanone(MEK)	µg/L	1	100.0%	0.000	0.000	ND	ND	
4-Methyl-2-pentanone	(MIBK)	µg/L	1	100.0%	0.000	NaN	ND	
2-Chloroethyl vinyl ether	µg/L	1	100.0%	0.000	0.000	ND	ND	
2-Hexanone	µg/L	1	100.0%	0.000	0.000	ND	ND	
4-Bromofluorobenzene	%	1	0.0%	108.800	108.800	108.800	108.800	
Acetone	µg/L	1	100.0%	0.000	0.000	ND	ND	
Benzene	µg/L	3	100.0%	0.000	0.000	ND	ND	
Benzyl alcohol	µg/L	1	100.0%	0.000	0.000	ND	ND	
Bromobenzene	µg/L	1	100.0%	0.000	0.000	ND	ND	
Bromochloromethane	µg/L	1	100.0%	0.000	0.000	ND	ND	
Bromodichloromethane	µg/L	3	100.0%	0.000	0.000	ND	ND	
Bromoform	µg/L	3	100.0%	0.000	0.000	ND	ND	
Bromomethane	µg/L	3	100.0%	0.000	0.000	ND	ND	
Carbon disulfide	µg/L	1	100.0%	0.000	0.000	ND	ND	
Carbon tetrachloride	µg/L	3	100.0%	0.000	0.000	ND	ND	
Chlorobenzene	µg/L	3	100.0%	0.000	0.000	ND	ND	
Chloroethane	µg/L	3	100.0%	0.000	0.000	ND	ND	
Chloroform	µg/L	3	33.3%	7.000	10.000	ND	11.000	
Chloromethane	µg/L	3	100.0%	0.000	0.000	ND	ND	
cis-1,2-Dichloroethene	µg/L	3	100.0%	0.000	0.000	ND	ND	
cis-1,3-Dichloropropene	µg/L	3	100.0%	0.000	0.000	ND	ND	

Table A-1. Categorical Process Monitoring Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max	Regulatory Limit
Dibromochloromethane	µg/L	3	100.0%	0.000	0.000	ND	ND	
Dibromomethane	µg/L	1	100.0%	0.000	0.000	ND	ND	
Dichlorodifluoromethane	µg/L	1	100.0%	0.000	0.000	ND	ND	
Ethyl benzene	µg/L	3	100.0%	0.000	0.000	ND	ND	
Freon 113	µg/L	2	100.0%	0.000	0.000	ND	ND	
Isopropyl benzene	µg/L	1	100.0%	0.000	0.000	ND	ND	
Methylene chloride	µg/L	3	100.0%	0.000	0.000	ND	ND	
o-Xylene	µg/L	2	100.0%	0.000	0.000	ND	ND	
p,m-Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND	
Styrene	µg/L	1	100.0%	0.000	0.000	ND	ND	
Tetrachloroethene	µg/L	3	100.0%	0.000	0.000	ND	ND	
Toluene	µg/L	3	100.0%	0.000	0.000	ND	ND	
Total Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND	
trans-1,2-Dichloroethene	µg/L	3	100.0%	0.000	0.000	ND	ND	
trans-1,3-Dichloropropene	µg/L	3	100.0%	0.000	0.000	ND	ND	
TRICHLOROTRIFLUOROETHANE	µg/L	1	100.0%	0.000	0.000	ND	ND	
Trichloroethene	µg/L	3	100.0%	0.000	0.000	ND	ND	
Trichlorofluoromethane	µg/L	3	100.0%	0.000	0.000	ND	ND	
Vinyl acetate	µg/L	1	100.0%	0.000	0.000	ND	ND	
Vinyl chloride	µg/L	3	100.0%	0.000	0.000	ND	ND	

[a]Limit for total Toxic Organics

Table A-2. Sanitary Sewer Monitoring Results.

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max	Regulatory Limit
Dioxins and Furans								1000[a]
Dibenzofuran	µg/L	23	100.0%	6.957	5.000	ND	ND	
Inorganic Parameters								
Biochemical Oxygen Demand	mg/L	23	0.0%	557.043	340	23	2000	None
Chemical Oxygen Demand	mg/L	23	0.0%	602.522	420	30	2100	None
Cyanide	Mg/L	5	60.0%	0.014	0.010	ND	0.020	0.04
Total Suspended Solids	Mg/L	21	0.0%	751.762	630	48	2300	
Total cyanide	Mg/L	14	100.0%	0.013	0.010	ND	ND	
Total Oil and Grease	Mg/L	8	0.0%	28.125	26	19	42	100
Metals								
Arsenic	mg/L	60	100.0%	0.005	0.005	ND	ND	0.06
Cadmium	mg/L	60	93.3%	0.004	0.005	ND	0.008	0.14
Chromium	mg/L	60	68.3%	0.012	0.010	ND	0.040	1.0
Copper	mg/L	59	1.7%	0.244	0.200	ND	0.740	0.62
Lead	mg/L	60	76.7%	0.039	0.050	ND	0.070	0.20
Mercury	mg/L	60	81.7%	0.009	0.001	ND	0.480	0.01
Nickel	mg/L	60	86.7%	0.017	0.020	ND	0.030	0.61
Silver	mg/L	60	78.3%	0.010	0.010	ND	0.020	0.20
Zinc	mg/L	60	0.0%	0.557	0.480	0.090	2.000	3.0
Semi-volatile OrganicCompounds								1000[a]
2,4,6-Trichlorophenol	µg/L	23	100.0%	6.957	5.000	ND	ND	

Table A-2. Sanitary Sewer Monitoring Results. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max	Regulatory Limit
2,4-Dichlorophenol	µg/L	23	100.0%	6.957	5.000	ND	ND	
2,4-Dimethylphenol	µg/L	23	100.0%	6.957	5.000	ND	ND	
2,4-Dinitrophenol	µg/L	23	100.0%	28.000	20.000	ND	ND	
2,4-Dinitrotoluene	µg/L	23	100.0%	6.957	5.000	ND	ND	
2,6-Dinitrotoluene	µg/L	23	100.0%	8.696	5.000	ND	ND	
2-Chloronaphthalene	µg/L	23	100.0%	6.957	5.000	ND	ND	
2-Chlorophenol	µg/L	23	100.0%	6.957	5.000	ND	ND	
2-Methyl-4,6-dinitrophenol	µg/L	18	100.0%	30.222	20.000	ND	ND	
3,3'-Dichlorobenzidine	µg/L	16	100.0%	43.750	40.000	ND	ND	
4-Bromophenyl phenyl ether	µg/L	23	100.0%	8.696	5.000	ND	ND	
4-Chloro-3-methylphenol	µg/L	23	100.0%	8.696	5.000	ND	ND	
Acenaphthene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Acenaphthylene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Anthracene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Benzidine	µg/L	21	100.0%	63.333	50.000	ND	ND	
1,3-Dichlorobenzidine	µg/L	5	100.0%	20.000	20.000	ND	ND	
Benzo(a)anthracene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Benzo(a)pyrene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Benzo(b)fluoranthene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Benzo(ghi)perylene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Benzo(k)fluoranthene	µg/L	23	100.0%	6.957	5.000	ND	ND	
bis(2-chloroethoxy) methane	µg/L	23	100.0%	8.696	5.000	ND	ND	
bis(2-chloroethyl) ether	µg/L	23	100.0%	6.957	5.000	ND	ND	
bis(2-chloroisopropyl) ether	µg/L	23	100.0%	6.957	5.000	ND	ND	
bis(2-Ethylhexyl) phthalate	µg/L	23	91.3%	13.087	10.000	ND	50.000	
Butyl benzyl phthalate	µg/L	7	100.0%	13.143	5.000	ND	ND	
Chrysene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Di-n-butyl phthalate	µg/L	23	100.0%	8.696	5.000	ND	ND	
Di-n-octyl phthalate	µg/L	23	95.7%	9.087	5.000	ND	36.000	
Dibenzo(a,h)anthracene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Diethyl phthalate	µg/L	23	100.0%	8.696	5.000	ND	ND	
Dimethyl phthalate	µg/L	23	100.0%	11.826	10.000	ND	ND	
Fluoranthene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Fluorene	µg/L	23	100.0%	8.696	5.000	ND	ND	
Hexachlorobenzene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Hexachlorobutadiene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Hexachlorocyclopentadiene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Hexachloroethane	µg/L	23	100.0%	6.957	5.000	ND	ND	
Indeno(1,2,3-cd)pyrene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Isophorone	µg/L	23	100.0%	6.957	5.000	ND	ND	
N-Nitroso-Di-n-propylamine	µg/L	23	100.0%	6.957	5.000	ND	ND	
N-Nitrosodimethylamine	µg/L	5	100.0%	5.000	5.000	ND	ND	
N-nitrosodiphenylamine	µg/L	23	100.0%	6.957	5.000	ND	ND	
Naphthalene	µg/L	25	100.0%	6.480	5.000	ND	ND	
Nitrobenzene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Pentachlorophenol	µg/L	23	100.0%	28.000	20.000	ND	ND	
Phenanthrene	µg/L	23	100.0%	6.957	5.000	ND	ND	
Phenol	µg/L	23	39.1%	11.435	8.000	ND	30.000	
Pyrene	µg/L	23	100.0%	6.957	5.000	ND	ND	

Table A-2. Sanitary Sewer Monitoring Results. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max	Regulatory Limit
Volatile Organic Compounds								1000[a]
1,1,2,2-Tetrachloroethane	µg/L	21	100.0%	2.476	1.000	ND	ND	
1,1,2-Trichloroethane	µg/L	21	100.0%	2.476	1.000	ND	ND	
1,1-Dichloroethane	µg/L	21	100.0%	2.476	1.000	ND	ND	
1,1-Dichloroethene	µg/L	21	100.0%	2.476	1.000	ND	ND	
1,2,4-Trichlorobenzene	µg/L	23	100.0%	6.957	5.000	ND	ND	
1,2-Dichloroethane	µg/L	21	100.0%	2.476	1.000	ND	ND	
1,2-Dichloroethene (total)	µg/L	14	100.0%	10.000	10.000	ND	ND	
1,2-Dichloropropane	µg/L	21	100.0%	2.476	1.000	ND	ND	
1,3-Dichlorobenzene	µg/L	44	100.0%	4.818	5.000	ND	ND	
1,4-Dichlorobenzene	µg/L	44	100.0%	4.818	5.000	ND	ND	
Bromoform	µg/L	21	100.0%	2.476	1.000	ND	ND	
Bromomethane	µg/L	21	100.0%	2.524	1.000	ND	ND	
Chlorobenzene	µg/L	21	100.0%	2.476	1.000	ND	ND	
Chloroethane	µg/L	21	100.0%	2.524	1.000	ND	ND	
Chloroform	µg/L	23	13.0%	7.809	8.000	ND	15.000	
Chloromethane	µg/L	21	100.0%	2.524	1.000	ND	ND	
cis-1,2-Dichloroethene	µg/L	21	100.0%	2.476	1.000	ND	ND	
cis-1,3-Dichloropropene	µg/L	21	100.0%	2.476	1.000	ND	ND	
Dibromochloromethane	µg/L	21	100.0%	2.476	1.000	ND	ND	
Freon 113	µg/L	19	100.0%	2.684	1.000	ND	ND	
o-Xylene	µg/L	19	100.0%	2.684	1.000	ND	ND	
p,m-Xylenes	µg/L	19	85.7%	3.643	5.000	ND	5.000	
Toluene	µg/L	21	76.2%	3.429	4.000	ND	8.000	
Total Xylenes	µg/L	16	93.8%	6.125	6.500	ND	10.000	
trans-1,2-Dichloroethene	µg/L	21	100.0%	2.476	1.000	ND	ND	
trans-1,3-Dichloropropene	µg/L	21	100.0%	2.476	1.000	ND	ND	
Trichloroethene	µg/L	21	100.0%	2.476	1.000	ND	ND	
Trichlorofluoromethane	µg/L	21	100.0%	2.619	1.000	ND	ND	

[a]The regulatory limit for Total Toxic Organics is 1000 µg/L.

Table A-3. Stormwater Monitoring Results.

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
STATION A							
Inorganic Parameters							
Ammonia-Nitrogen	mg/L	1	0.0%			0.05	0.05
Chemical Oxygen Demand	mg/L	1	0.0%			11.0	11.0
Nitrite-N	mg/L	1	0.0%			0.025	0.025
Oil & Grease (total)	mg/L	2	50.0%	3.300	3.3	ND	5
pH	s.u.	2	0.0%	7.25	7.25	7.21	7.3
Specific Conductance	µmhos/cm	2	0.0%	26.039	26.039	0.078	52.000
Total cyanide	mg/L	2	100%	0.010	0.010	ND	ND
Total Suspended Solids	mg/L	2	0.0%	26.500	26.500	13	40
Metals							
Aluminum	mg/L	2	0.0%	0.665	0.665	0.33	1.00
Arsenic	mg/L	1	100%			ND	ND
Cadmium	mg/L	1	100%			ND	ND
Iron	mg/L	2	0.0%	0.655	0.655	0.31	1.00
Lead	mg/L	1	100%			ND	ND
Magnesium	mg/L	2	0.0%	1.300	1.300	0.80	1.80
Mercury	mg/L	1	100%			ND	ND
Selenium	mg/L	2	100%	0.000	0.000	ND	ND
Silver	mg/L	1	100%			ND	ND
Zinc	mg/L	2	0.0%	0.170	0.170	0.14	0.20
Radiochemical parameters							
TRITIUM	mg/L	1	100%			ND	ND
STATION B							
Inorganic Parameters							
Ammonia-Nitrogen	mg/L	1	100%			ND	ND
Chemical Oxygen Demand	mg/L	1	0.0%			27	27
Nitrate-N	mg/L	1	0.0%			0.025	0.025
Nitrite-N	mg/L	1	0.0%			0.090	0.090
Oil & Grease (total)	mg/L	1	100%			ND	ND
Specific Conductance	µmhos/cm	1	0.0%			110	110
Total cyanide	mg/L	2	100%			ND	ND
Total Suspended Solids	mg/L	2	0.0%	3890	3890	180	7600
Metals							
Aluminum	mg/L	1	0.0%			5.7	5.7
Iron	mg/L	1	0.0%			7.3	7.3
Magnesium	mg/L	1	0.0%			3.5	3.5
Selenium	mg/L	1	100%			ND	ND
Zinc	mg/L	1	0.0%			4.7	4.7
Radiochemical parameters							
TRITIUM	mg/L	1	100%			ND	ND
STATION C							
Inorganic Parameters							
Ammonia-Nitrogen	mg/L	1	0.0%			0.06	0.06
Chemical Oxygen Demand	mg/L	1	0.0%			11	11
Nitrate-N	mg/L	1	0.0%			0.025	0.025
Nitrite-N	mg/L	1	0.0%			0.120	0.120
Oil & Grease (total)	mg/L	2	50.0%	3.600	3.600	ND	5.000

Table A-3. Stormwater Monitoring Results. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
pH	s.u.	2	0.0%	7.085	7.085	6.870	7.300
Specific Conductance	µmhos/cm	2	0.0%	18.533	18.532	0.065	37.000
Total cyanide	mg/L	2	100%			ND	ND
Total Suspended Solids	mg/L	2	0.0%	60.5	60.5	41	80
Metals							
Aluminum	mg/L	2	0.0%	3.55	3.55	2.6	4.5
Arsenic	mg/L	1	100%			ND	ND
Cadmium	mg/L	1	100%			ND	ND
Iron	mg/L	2	0.0%	3.75	3.75	2.8	4.7
Lead	mg/L	1	0.0%			0.005	0.005
Magnesium	mg/L	2	0.0%	2.350	2.350	2.300	2.400
Mercury	mg/L	1	100			ND	ND
Selenium	mg/L	2	100%			ND	ND
Silver	mg/L	1	100%			ND	ND
Zinc	mg/L	2	0.0%	0.21	0.21	0.20	0.22
Radiochemical parameters							
TRITIUM	mg/L	1	100%			ND	ND
STATION D							
Inorganic Parameters							
Ammonia-Nitrogen	mg/L	1	100%			ND	ND
Chemical Oxygen Demand	mg/L	1	0.0%			11	11
Nitrate-N	mg/L	1	0.0%			0.025	0.025
Nitrite-N	mg/L	1	0.0%			0.170	0.170
Oil & Grease (total)	mg/L	1	100%			ND	ND
pH	s.u.	1	0.0%			7.500	7.500
Specific Conductance	µmhos/cm	1	0.0%			71.000	71.000
Total cyanide	mg/L	1	100%			ND	ND
Total Suspended Solids	mg/L	1	0.0%			90.000	90.000
Metals							
Aluminum	mg/L	1	0.0%			3.100	3.100
Iron	mg/L	1	0.0%			3.100	3.100
Magnesium	mg/L	1	0.0%			1.900	1.900
Selenium	mg/L	1	100%			ND	ND
Zinc	mg/L	1	0.0%			0.090	0.090
Radiochemical parameters							
TRITIUM	mg/L	1	100%			ND	ND
STATION F							
Inorganic Parameters							
Ammonia-Nitrogen	mg/L	1	100%			ND	ND
Chemical Oxygen Demand	mg/L	1	0.0%			11.000	11.000
Nitrate-N	mg/L	1	0.0%			0.025	0.025
Nitrite-N	mg/L	1	0.0%			0.100	0.100
Oil & Grease (total)	mg/L	1	0.0%			17.000	17.000
pH	s.u.	1	0.0%			9.000	9.000
Specific Conductance	µmhos/cm	1	0.0%			57.000	57.000
Total cyanide	mg/L	2	100%			ND	ND
Total Suspended Solids	mg/L	1	0.0%			230.000	230.000
Metals							
Aluminum	mg/L	1	0.0%			4.200	4.200

Table A-3. Stormwater Monitoring Results. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
Iron	mg/L	1	0.0%			4.700	4.700
Magnesium	mg/L	1	0.0%			2.000	2.000
Selenium	mg/L	1	100%			ND	ND
Zinc	mg/L	1	0.0%			0.220	0.220
Radiochemical parameters							
TRITIUM	mg/L	1	100%			ND	ND
STATION G							
Inorganic Parameters							
Ammonia-Nitrogen	mg/L	1	100%			ND	ND
Chemical Oxygen Demand	mg/L	1	0.0%			11.000	11.000
Nitrate-N	mg/L	1	0.0%			0.025	0.025
Nitrite-N	mg/L	1	0.0%			0.150	0.150
Oil & Grease (total)	mg/L	2	100%			ND	ND
pH	s.u.	2	0.0%	7.385	7.385	7.300	7.470
Specific Conductance	µmhos/cm	2	0.0%	20.543	20.543	0.085	41.000
Total cyanide	mg/L	2	100%			ND	ND
Total Suspended Solids	mg/L	2	0.0%	37.000	37.000	14.000	60.000
Metals							
Aluminum	mg/L	2	0.0%	0.990	0.990	0.980	1.000
Arsenic	mg/L	1	100%			ND	ND
Cadmium	mg/L	1	100%			ND	ND
Iron	mg/L	2	0.0%	1.100	1.100	1.000	1.200
Lead	mg/L	1	100%			ND	ND
Magnesium	mg/L	2	0.0%	1.260	1.260	0.820	1.700
Mercury	mg/L	1	100%			ND	ND
Selenium	mg/L	2	100%			ND	ND
Silver	mg/L	1	100%			ND	ND
Zinc	mg/L	2	0.0%	0.175	0.175	0.120	0.230
Radiochemical parameters							
TRITIUM	mg/L	1	100%			ND	ND
STATION X							
Inorganic Parameters							
Ammonia-Nitrogen	mg/L	1	0.0%			0.060	0.060
Chemical Oxygen Demand	mg/L	1	0.0%			8.000	8.000
Nitrate-N	mg/L	1	0.0%			0.025	0.025
Nitrite-N	mg/L	1	0.0%			0.100	0.100
Oil & Grease (total)	mg/L	1	100%			ND	ND
pH	s.u.	1	0.0%			7.300	7.300
Specific Conductance	µmhos/cm	1	0.0%			31.000	31.000
Total cyanide	mg/L	2	100%			ND	ND
Total Suspended Solids	mg/L	1	100%			ND	ND
Metals							
Aluminum	mg/L	1	0.0%			0.300	0.300
Iron	mg/L	1	0.0%			0.320	0.320
Magnesium	mg/L	1	0.0%			0.500	0.500
Selenium	mg/L	1	100%			ND	ND
Zinc	mg/L	1	0.0%			0.060	0.060
Radiochemical parameters							
TRITIUM	mg/L	1	100%			ND	ND

Table A-3. Stormwater Monitoring Results. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
STATION Y							
Inorganic Parameters							
Ammonia-Nitrogen	mg/L	2	100%			ND	ND
Chemical Oxygen Demand	mg/L	2	0.0%	15.000	15.000	13.000	17.000
Nitrate-N	mg/L	3	0.0%	0.025	0.025	0.025	0.025
Nitrite-N	mg/L	2	0.0%	0.025	0.025	0.025	0.025
Oil & Grease (total)	mg/L	2	100%			ND	ND
pH	s.u.	2	0.0%	8.2	8.2	8.2	8.2
Specific Conductance	µmhos/cm	2	0.0%	1900	1900	1800	2000
Total cyanide	mg/L	2	100%			ND	ND
Total Suspended Solids	mg/L	2	0.0%	15	15	10	20
Metals							
Aluminum	mg/L	2	50.0%	0.075	0.075	ND	0.100
Iron	mg/L	2	0.0%	0.100	0.100	0.080	0.120
Magnesium	mg/L	2	0.0%	81.000	81.000	73.000	89.000
Selenium	mg/L	2	100%			ND	ND
Zinc	mg/L	2	50.0%	0.015	0.015	ND	0.020
Radiochemical parameters							
TRITIUM	mg/L	2	100%			ND	ND
STATION Z							
Inorganic Parameters							
Ammonia-Nitrogen	mg/L	1	100%			ND	ND
Chemical Oxygen Demand	mg/L	1	0.0%			24.000	24.000
Nitrite-N	mg/L	2	0.0%	0.063	0.063	0.025	0.100
Oil & Grease (total)	mg/L	2	50.0%	3.000	3.000	ND	5.000
pH	s.u.	2	0.0%	7.200	7.200	7.000	7.400
Specific Conductance	µmhos/cm	2	0.0%	17.534	17.535	0.069	35.000
Total cyanide	mg/L	2	100%			ND	ND
Total Suspended Solids	mg/L	2	0.0%	15	15	10	20
Metals							
Aluminum	mg/L	2	0.0%	1.580	1.580	0.760	2.400
Arsenic	mg/L	1	100%			ND	ND
Cadmium	mg/L	1	100%			ND	ND
Iron	mg/L	2	0.0%	1.505	1.505	0.810	2.200
Lead	mg/L	1	100%			ND	ND
Magnesium	mg/L	2	0.0%	1.640	1.640	0.980	2.300
Mercury	mg/L	1	100%			ND	ND
Selenium	mg/L	2	100%			ND	ND
Silver	mg/L	1	100%			ND	ND
Zinc	mg/L	2	0.0%	0.105	0.105	0.070	0.140
Radiochemical parameters							
TRITIUM	mg/L	2	100%			ND	ND

Table A-4. Groundwater Monitoring Analytical Data.

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
AS-3A							
Inorganic Parameters							
Alkalinity -Bicarbonate	mg/L	1	0.0%	230	230	230	230
Alkalinity -Carbonate	mg/L	1	100.0%	0.000	0.000	ND	ND
Alkalinity -Total	mg/L	1	0.0%	230	230	230	230
Alkalinity, hydroxide	mg/L	1	100.0%			ND	ND
Chloride	mg/L	1	0.0%			75	75
Hardness (as CaCO3)	mg/L	1	0.0%			310	310
MBAS	mg/L	1	100.0%			ND	ND
Nitrate as NO3	mg/L	1	0.0%			18	18
pH	s.u.	1	0.0%			7.8	7.8
Solids, Total Dissolved	mg/L	1	0.0%			540	540
Specific Conductance	µmhos/cm	1	0.0%			900	900
Sulfate	mg/L	1	0.0%			125	125
Metals							
Aluminum	mg/L	1	0.0%			0.37	0.37
Antimony	mg/L	1	100.0%			ND	ND
Arsenic	mg/L	1	100.0%			ND	ND
Barium	mg/L	1	0.0%			0.10	0.10
Beryllium	mg/L	1	100.0%			ND	ND
Cadmium	mg/L	1	100.0%			ND	ND
Calcium	mg/L	1	0.0%			66	66
Chromium	mg/L	1	0.0%			0.007	0.007
Cobalt	mg/L	1	100.0%			ND	ND
Copper	mg/L	1	100.0%			ND	ND
Iron	mg/L	1	0.0%			0.33	0.33
Lead	mg/L	1	100.0%			ND	ND
Magnesium	mg/L	1	0.0%			29	29
Manganese	mg/L	1	0.0%			0.008	0.008
Mercury	mg/L	1	100.0%			ND	ND
Molybdenum	mg/L	1	0.0%			0.006	0.006
Nickel	mg/L	1	100.0%			ND	ND
Potassium	mg/L	1	0.0%			3.4	3.4
Selenium	mg/L	1	100.0%			ND	ND
Silver	mg/L	1	100.0%			ND	ND
Sodium	mg/L	1	0.0%			94	94
Thallium	mg/L	1	100.0%			ND	ND
Vanadium	mg/L	1	100.0%			ND	ND
Zinc	mg/L	1	100.0%			ND	ND
Radiochemical parameters							
TRITIUM	pCi/L	3	0.0%	27	45	-34	70
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	1	100.0%			ND	ND
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	1	100.0%			ND	ND
1,1,2,2-Tetrachloroethane	µg/L	1	100.0%			ND	ND
1,1,2-Trichloroethane	µg/L	1	100.0%			ND	ND
1,1-Dichloroethane	µg/L	1	100.0%			ND	ND
1,1-Dichloroethene	µg/L	1	100.0%			ND	ND
1,2-Dichlorobenzene	µg/L	1	100.0%			ND	ND

Table A-4. Groundwater Monitoring Analytical Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
1,2-Dichloroethane	µg/L	1	100.0%			ND	ND
1,2-Dichloroethene (Total)	µg/L	1	100.0%			ND	ND
1,2-Dichloropropane	µg/L	1	100.0%			ND	ND
1,3-Dichlorobenzene	µg/L	1	100.0%			ND	ND
1,4-Dichlorobenzene	µg/L	1	100.0%			ND	ND
Bromodichloromethane	µg/L	1	100.0%			ND	ND
Bromoform	µg/L	1	100.0%			ND	ND
Bromomethane	µg/L	1	100.0%			ND	ND
Carbon tetrachloride	µg/L	1	100.0%			ND	ND
Chlorobenzene	µg/L	1	100.0%			ND	ND
Chloroethane	µg/L	1	100.0%			ND	ND
Chloroform	µg/L	1	100.0%			ND	ND
Chloromethane	µg/L	1	100.0%			ND	ND
cis-1,2-Dichloroethene	µg/L	1	100.0%			ND	ND
cis-1,3-Dichloropropene	µg/L	1	100.0%			ND	ND
Dibromochloromethane	µg/L	1	100.0%			ND	ND
Dichlorodifluoromethane	µg/L	1	100.0%			ND	ND
Freon 113	µg/L	1	100.0%			ND	ND
Methylene chloride	µg/L	1	100.0%			ND	ND
Tetrachloroethene	µg/L	1	100.0%			ND	ND
trans-1,2-Dichloroethene	µg/L	1	100.0%			ND	ND
trans-1,3-Dichloropropene	µg/L	1	100.0%			ND	ND
Trichloroethene	µg/L	1	100.0%			ND	ND
Trichlorofluoromethane	µg/L	1	100.0%			ND	ND
Vinyl chloride	µg/L	1	100.0%			ND	ND
AS-3B							
Inorganic Parameters							
Alkalinity -Bicarbonate	mg/L	1	0.0%			230	230
Alkalinity -Carbonate	mg/L	1	100.0%			ND	ND
Alkalinity -Total	mg/L	1	0.0%			230	230
Alkalinity, hydroxide	mg/L	1	100.0%			ND	ND
Chloride	mg/L	1	0.0%			82	82
Hardness (as CaCO3)	mg/L	1	0.0%			340	340
MBAS	mg/L	1	100.0%			ND	ND
Nitrate as NO3	mg/L	1	0.0%			24	24
pH	s.u.	1	0.0%			7.7	7.7
Solids, Total Dissolved	mg/L	1	0.0%			560	560
Specific Conductance	µmhos/cm	1	0.0%			940	940
Sulfate	mg/L	1	0.0%			140	140
Metals							
Aluminum	mg/L	1	0.0%			0.26	0.26
Antimony	mg/L	1	100.0%			ND	ND
Arsenic	mg/L	1	100.0%			ND	ND
Barium	mg/L	1	0.0%			0.11	0.11
Beryllium	mg/L	1	100.0%			ND	ND
Cadmium	mg/L	1	100.0%			ND	ND
Calcium	mg/L	1	0.0%			71	71
Chromium	mg/L	1	100.0%			ND	ND
Cobalt	mg/L	1	100.0%			ND	ND
Copper	mg/L	1	100.0%			ND	ND

Table A-4. Groundwater Monitoring Analytical Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
Iron	mg/L	1	0.0%			0.23	0.23
Lead	mg/L	1	100.0%			ND	ND
Magnesium	mg/L	1	0.0%			33	33
Manganese	mg/L	1	0.0%			0.025	0.025
Mercury	mg/L	1	100.0%			ND	ND
Molybdenum	mg/L	1	100.0%			ND	ND
Nickel	mg/L	1	100.0%			ND	ND
Potassium	mg/L	1	0.0%			2.9	2.9
Selenium	mg/L	1	100.0%			ND	ND
Silver	mg/L	1	100.0%			ND	ND
Sodium	mg/L	1	0.0%			93	93
Thallium	mg/L	1	100.0%			ND	ND
Vanadium	mg/L	1	100.0%			ND	ND
Zinc	mg/L	1	0.0%			0.017	0.017
Radiochemical parameters							
TRITIUM	pCi/L	1	0.0%			532	532
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	1	100.0%			ND	ND
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	1	100.0%			ND	ND
1,1,2,2-Tetrachloroethane	µg/L	1	100.0%			ND	ND
1,1,2-Trichloroethane	µg/L	1	100.0%			ND	ND
1,1-Dichloroethane	µg/L	1	100.0%			ND	ND
1,1-Dichloroethene	µg/L	1	100.0%			ND	ND
1,2-Dichlorobenzene	µg/L	1	100.0%			ND	ND
1,2-Dichloroethane	µg/L	1	100.0%			ND	ND
1,2-Dichloroethene (Total)	µg/L	1	100.0%			ND	ND
1,2-Dichloropropane	µg/L	1	100.0%			ND	ND
1,3-Dichlorobenzene	µg/L	1	100.0%			ND	ND
1,4-Dichlorobenzene	µg/L	1	100.0%			ND	ND
Bromodichloromethane	µg/L	1	100.0%			ND	ND
Bromoform	µg/L	1	100.0%			ND	ND
Bromomethane	µg/L	1	100.0%			ND	ND
Carbon tetrachloride	µg/L	1	100.0%			ND	ND
Chlorobenzene	µg/L	1	100.0%			ND	ND
Chloroethane	µg/L	1	100.0%			ND	ND
Chloroform	µg/L	1	100.0%			ND	ND
Chloromethane	µg/L	1	100.0%			ND	ND
cis-1,2-Dichloroethene	µg/L	1	100.0%			ND	ND
cis-1,3-Dichloropropene	µg/L	1	100.0%			ND	ND
Dibromochloromethane	µg/L	1	100.0%			ND	ND
Dichlorodifluoromethane	µg/L	1	100.0%			ND	ND
Freon 113	µg/L	1	100.0%			ND	ND
Methylene chloride	µg/L	1	100.0%			ND	ND
Tetrachloroethene	µg/L	1	100.0%			ND	ND
trans-1,2-Dichloroethene	µg/L	1	100.0%			ND	ND
trans-1,3-Dichloropropene	µg/L	1	100.0%			ND	ND
Trichloroethene	µg/L	1	100.0%			ND	ND
Trichlorofluoromethane	µg/L	1	100.0%			ND	ND
Vinyl chloride	µg/L	1	100.0%			ND	ND

Table A-4. Groundwater Monitoring Analytical Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
AS-3C							
Inorganic Parameters							
Alkalinity-Bicarbonate	mg/L	1	0.0%			170	170
Alkalinity-Carbonate	mg/L	1	100.0%			ND	ND
Alkalinity-Total	mg/L	1	0.0%			170	170
Alkalinity,hydroxide	mg/L	1	100.0%			ND	ND
Chloride	mg/L	1	0.0%			75	75
Hardness (as CaCO3)	mg/L	1	0.0%			280	280
MBAS	mg/L	1	100.0%			ND	ND
Nitrate as NO3	mg/L	1	0.0%			36	36
pH	s.u.	1	0.0%			8.1	8.1
Solids, Total Dissolved	mg/L	1	0.0%			520	520
Specific Conductance	µmhos/cm	1	0.0%			920	920
Sulfate	mg/L	1	0.0%			172	172
Metals							
Aluminum	mg/L	1	100.0%			ND	ND
Antimony	mg/L	1	100.0%			ND	ND
Arsenic	mg/L	1	100.0%			ND	ND
Barium	mg/L	1	0.0%			0.10	0.10
Beryllium	mg/L	1	100.0%			ND	ND
Cadmium	mg/L	1	100.0%			ND	ND
Calcium	mg/L	1	0.0%			54	54
Chromium	mg/L	1	100.0%			ND	ND
Cobalt	mg/L	1	100.0%			ND	ND
Copper	mg/L	1	100.0%			ND	ND
Iron	mg/L	1	100.0%			ND	ND
Lead	mg/L	1	100.0%			ND	ND
Magnesium	mg/L	1	0.0%			29	29
Manganese	mg/L	1	100.0%			ND	ND
Mercury	mg/L	1	100.0%			ND	ND
Molybdenum	mg/L	1	0.0%			0.007	0.007
Nickel	mg/L	1	100.0%			ND	ND
Potassium	mg/L	1	0.0%			3.1	3.1
Selenium	mg/L	1	100.0%			ND	ND
Silver	mg/L	1	100.0%			ND	ND
Sodium	mg/L	1	0.0%			120	120
Thallium	mg/L	1	100.0%			ND	ND
Vanadium	mg/L	1	100.0%			ND	ND
Zinc	mg/L	1	100.0%			ND	ND
Radiochemical parameters							
TRITIUM	pCi/L	1	0.0%			-101	-101
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	1	100.0%			ND	ND
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	1	100.0%			ND	ND
1,1,2,2-Tetrachloroethane	µg/L	1	100.0%			ND	ND
1,1,2-Trichloroethane	µg/L	1	100.0%			ND	ND
1,1-Dichloroethane	µg/L	1	100.0%			ND	ND
1,1-Dichloroethene	µg/L	1	100.0%			ND	ND
1,2-Dichlorobenzene	µg/L	1	100.0%			ND	ND

Table A-4. Groundwater Monitoring Analytical Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
1,2-Dichloroethane	µg/L	1	100.0%			ND	ND
1,2-Dichloroethene (Total)	µg/L	1	100.0%			ND	ND
1,2-Dichloropropane	µg/L	1	100.0%			ND	ND
1,3-Dichlorobenzene	µg/L	1	100.0%			ND	ND
1,4-Dichlorobenzene	µg/L	1	100.0%			ND	ND
Bromodichloromethane	µg/L	1	100.0%			ND	ND
Bromoform	µg/L	1	100.0%			ND	ND
Bromomethane	µg/L	1	100.0%			ND	ND
Carbon tetrachloride	µg/L	1	100.0%			ND	ND
Chlorobenzene	µg/L	1	100.0%			ND	ND
Chloroethane	µg/L	1	100.0%			ND	ND
Chloroform	µg/L	1	100.0%			ND	ND
Chloromethane	µg/L	1	100.0%			ND	ND
cis-1,2-Dichloroethene	µg/L	1	100.0%			ND	ND
cis-1,3-Dichloropropene	µg/L	1	100.0%			ND	ND
Dibromochloromethane	µg/L	1	100.0%			ND	ND
Dichlorodifluoromethane	µg/L	1	100.0%			ND	ND
Freon 113	µg/L	1	100.0%			ND	ND
Methylene chloride	µg/L	1	100.0%			ND	ND
Tetrachloroethene	µg/L	1	100.0%			ND	ND
trans-1,2-Dichloroethene	µg/L	1	100.0%			ND	ND
trans-1,3-Dichloropropene	µg/L	1	100.0%			ND	ND
Trichloroethene	µg/L	1	100.0%			ND	ND
Trichlorofluoromethane	µg/L	1	100.0%			ND	ND
Vinyl chloride	µg/L	1	100.0%			ND	ND
AS-4							
Inorganic Parameters							
Alkalinity-Bicarbonate	mg/L	1	0.0%			360	360
Alkalinity-Carbonate	mg/L	1	100.0%			ND	ND
Alkalinity-Total	mg/L	1	0.0%			360	360
Alkalinity,hydroxide	mg/L	1	100.0%			ND	ND
Chloride	mg/L	1	0.0%			239	239
Hardness (as CaCO3)	mg/L	1	0.0%			730	730
MBAS	mg/L	1	100.0%			ND	ND
Nitrate as NO3	mg/L	1	0.0%			2.1	2.1
pH	s.u.	1	0.0%			7.4	7.4
Solids, Total Dissolved	mg/L	1	0.0%			1200	1200
Specific Conductance	µmhos/cm	1	0.0%			1800	1800.
Sulfate	mg/L	1	0.0%			351	351
Metals							
Aluminum	mg/L	1	0.0%			0.13	0.13
Antimony	mg/L	1	100.0%			ND	ND
Arsenic	mg/L	1	100.0%			ND	ND
Barium	mg/L	1	0.0%			0.075	0.075
Beryllium	mg/L	1	100.0%			ND	ND
Cadmium	mg/L	1	100.0%			ND	ND
Calcium	mg/L	1	0.0%			130	130
Chromium	mg/L	1	100.0%			ND	ND
Cobalt	mg/L	1	100.0%			ND	ND
Copper	mg/L	1	100.0%			ND	ND
Iron	mg/L	1	0.0%			0.12	0.12

Table A-4. Groundwater Monitoring Analytical Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
Lead	mg/L	1	100.0%			ND	ND
Magnesium	mg/L	1	0.0%			79	79
Manganese	mg/L	1	100.0%			ND	ND
Mercury	mg/L	1	100.0%			ND	ND
Molybdenum	mg/L	1	100.0%			ND	ND
Nickel	mg/L	1	100.0%			ND	ND
Potassium	mg/L	1	0.0%			3.5	3.5
Selenium	mg/L	1	100.0%			ND	ND
Silver	mg/L	1	100.0%			ND	ND
Sodium	mg/L	1	0.0%			180	180
Thallium	mg/L	1	100.0%			ND	ND
Vanadium	mg/L	1	100.0%			ND	ND
Zinc	mg/L	1	100.0%			ND	ND
Radiochemical parameters							
TRITIUM	pCi/L	1	0.0%			21	21
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	1	100.0%			ND	ND
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	1	100.0%			ND	ND
1,1,2,2-Tetrachloroethane	µg/L	1	100.0%			ND	ND
1,1,2-Trichloroethane	µg/L	1	100.0%			ND	ND
1,1-Dichloroethane	µg/L	1	100.0%			ND	ND
1,1-Dichloroethene	µg/L	1	100.0%			ND	ND
1,2-Dichlorobenzene	µg/L	1	100.0%			ND	ND
1,2-Dichloroethane	µg/L	1	100.0%			ND	ND
1,2-Dichloroethene (Total)	µg/L	1	100.0%			ND	ND
1,2-Dichloropropane	µg/L	1	100.0%			ND	ND
1,3-Dichlorobenzene	µg/L	1	100.0%			ND	ND
1,4-Dichlorobenzene	µg/L	1	100.0%			ND	ND
Bromodichloromethane	µg/L	1	100.0%			ND	ND
Bromoform	µg/L	1	100.0%			ND	ND
Bromomethane	µg/L	1	100.0%			ND	ND
Carbon tetrachloride	µg/L	1	100.0%			ND	ND
Chlorobenzene	µg/L	1	100.0%			ND	ND
Chloroethane	µg/L	1	100.0%			ND	ND
Chloroform	µg/L	1	100.0%			ND	ND
Chloromethane	µg/L	1	100.0%			ND	ND
cis-1,2-Dichloroethene	µg/L	1	100.0%			ND	ND
cis-1,3-Dichloropropene	µg/L	1	100.0%			ND	ND
Dibromochloromethane	µg/L	1	100.0%			ND	ND
Dichlorodifluoromethane	µg/L	1	100.0%			ND	ND
Freon 113	µg/L	1	100.0%			ND	ND
Methylene chloride	µg/L	1	100.0%			ND	ND
Tetrachloroethene	µg/L	1	100.0%			ND	ND
trans-1,2-Dichloroethene	µg/L	1	100.0%			ND	ND
trans-1,3-Dichloropropene	µg/L	1	100.0%			ND	ND
Trichloroethene	µg/L	1	100.0%			ND	ND
Trichlorofluoromethane	µg/L	1	100.0%			ND	ND
Vinyl chloride	µg/L	1	100.0%			ND	ND

Table A-4. Groundwater Monitoring Analytical Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
FDG-1							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	8	50.0%	48	30	ND	130
TPH-Extractables	µg/L	3	66.7%	20	0	ND	60
Xylene(s)	µg/L	1	100.0%	0.000	0.000	ND	ND
Volatile Organic Compounds							
a,a,a-Trifluorotoluene	µg/L	3	0.0%	0.000	0.000	0.000	0.000
Benzene	µg/L	8	100.0%	0.000	0.000	ND	ND
Ethyl benzene	µg/L	8	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	7	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	7	100.0%	0.000	0.000	ND	ND
Toluene	µg/L	8	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	7	100.0%	0.000	0.000	ND	ND
FDG-2							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	2	50.0%	40	40	ND	80.000
TPH-Extractables	µg/L	1	100.0%			ND	ND
Volatile Organic Co\mpounds							
a,a,a-Trifluorotoluene	µg/L	1	0.0%			0.000	0.000
Benzene	µg/L	2	100.0%			ND	ND
Ethyl benzene	µg/L	2	100.0%			ND	ND
o-Xylene	µg/L	2	100.0%			ND	ND
p,m-Xylenes	µg/L	2	100.0%			ND	ND
Toluene	µg/L	2	100.0%			ND	ND
Total Xylenes	µg/L	2	100.0%			ND	ND
FDG-3							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	4	100.0%	0.000	0.000	ND	ND
TPH-Extractables	µg/L	1	100.0%			ND	ND
Xylene(s)	µg/L	1	100.0%			ND	ND
Volatile Organic Compounds							
Benzene	µg/L	4	100.0%	0.000	0.000	ND	ND
Ethyl benzene	µg/L	4	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	3	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	3	100.0%	0.000	0.000	ND	ND
Toluene	µg/L	4	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	3	100.0%	0.000	0.000	ND	ND
FM-1							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	4	0.0%	28750	18000	11000	68000
TPH-Extractables	µg/L	1	0.0%			72000	72000
Xylene(s)	µg/L	1	100.0%			ND	ND
Volatile Organic Compounds							
Benzene	µg/L	4	75.0%	0.1	0.0	ND	0.4
Ethyl benzene	µg/L	4	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	3	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	3	100.0%	0.000	0.000	ND	ND
Toluene	µg/L	4	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	3	100.0%	0.000	0.000	ND	ND

Table A-4. Groundwater Monitoring Analytical Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
FM-10							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	2	100.0%	0.000	0.000	ND	ND
TPH-Extractables	µg/L	1	100.0%			ND	ND
Volatile Organic Compounds							
Benzene	µg/L	2	100.0%	0.000	0.000	ND	ND
Ethyl benzene	µg/L	2	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	2	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
Toluene	µg/L	2	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
FM-11							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	3	66.7%	90	0	ND	270
TPH-Extractables	µg/L	2	0.0%	850	850	600	1100
Volatile Organic Compounds							
Benzene	µg/L	2	100.0%	0.000	0.000	ND	ND
Ethyl benzene	µg/L	2	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	2	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
Toluene	µg/L	2	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
FM-12							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	1	0.0%			260	260
Volatile Organic Compounds							
Benzene	µg/L	1	100.0%			ND	ND
Ethyl benzene	µg/L	1	100.0%			ND	ND
o-Xylene	µg/L	1	100.0%			ND	ND
p,m-Xylenes	µg/L	1	100.0%			ND	ND
Toluene	µg/L	1	100.0%			ND	ND
Total Xylenes	µg/L	1	100.0%			ND	ND
FM-13							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	2	100.0%	0.000	0.000	ND	ND
TPH-Extractables	µg/L	1	100.0%			ND	ND
Volatile Organic Compounds							
Benzene	µg/L	2	100.0%	0.000	0.000	ND	ND
Ethyl benzene	µg/L	2	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	2	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
Toluene	µg/L	2	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
FM-14							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	2	100.0%	0.000	0.000	ND	ND
TPH-Extractables	µg/L	1	100.0%			ND	ND

Table A-4. Groundwater Monitoring Analytical Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
Volatile Organic Compounds							
Benzene	µg/L	2	100.0%	0.000	0.000	ND	ND
Ethyl benzene	µg/L	2	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	2	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
Toluene	µg/L	2	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
FM-2							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	2	0.0%	2550	2550	2200	2900
TPH-Extractables	µg/L	1	0.0%			2500	2500
Volatile Organic Compounds							
Benzene	µg/L	2	50.0%	0.5	0.5	ND	1.0
Ethyl benzene	µg/L	2	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	2	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
Toluene	µg/L	2	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
FM-3							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	2	0.0%	11000	11000	3000	19000
TPH-Extractables	µg/L	1	0.0%			20000	20000
Volatile Organic Compounds							
Benzene	µg/L	2	50.0%	0.2	0.2	ND	0.4
Ethyl benzene	µg/L	2	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	2	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
Toluene	µg/L	2	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
FM-4							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	2	0.0%	175000	175000	60000	290000
TPH-Extractables	µg/L	1	0.0%			290000	290000
Volatile Organic Compounds							
Benzene	µg/L	2	0.0%	7.35	7.35	6.0	8.7
Ethyl benzene	µg/L	2	50.0%	0.250	0.250	ND	0.5
o-Xylene	µg/L	2	0.0%	1.650	1.650	1.0	2.3
p,m-Xylenes	µg/L	2	0.0%	4.800	4.800	4.0	5.6
Toluene	µg/L	2	50.0%	0.250	0.250	ND	0.5
Total Xylenes	µg/L	2	0.0%	6.450	6.450	5.0	7.9
FM-5							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	2	100.0%	0.000	0.000	ND	ND
TPH-Extractables	µg/L	1	100.0%			ND	ND
Volatile Organic Compounds							
Benzene	µg/L	2	100.0%	0.000	0.000	ND	ND
Ethyl benzene	µg/L	2	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	2	100.0%	0.000	0.000	ND	ND

Table A-4. Groundwater Monitoring Analytical Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
p,m-Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
Toluene	µg/L	2	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
FM-6							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	4	50.0%	142	29	ND	510
TPH-Extractables	µg/L	2	0.0%	325	325	0.000	650
Xylene(s)	µg/L	1	100.0%	0.000	0.000	ND	ND
Volatile Organic Compounds							
Benzene	µg/L	4	100.0%	0.000	0.000	ND	ND
Ethyl benzene	µg/L	4	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	3	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	3	100.0%	0.000	0.000	ND	ND
Toluene	µg/L	4	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	3	100.0%	0.000	0.000	ND	ND
FM-7							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	4	0.0%	16550	11800	1600	41000
TPH-Extractables	µg/L	1	0.0%			22000	22000
Xylene(s)	µg/L	1	100.0%			ND	ND
Volatile Organic Compounds							
Benzene	µg/L	4	75.0%	0.275	0.000	ND	1.1
Ethyl benzene	µg/L	4	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	3	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	3	66.7%	0.133	0.000	ND	0.4
Toluene	µg/L	4	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	3	100.0%	0.000	0.000	ND	ND
FM-8							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	6	50.0%	190	40	ND	610
TPH-Extractables	µg/L	1	0.0%			690	690
Xylene(s)	µg/L	3	100.0%	0.000	0.000	ND	ND
Volatile Organic Compounds							
Benzene	µg/L	6	100.0%	0.000	0.000	ND	ND
Ethyl benzene	µg/L	6	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	3	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	3	100.0%	0.000	0.000	ND	ND
Toluene	µg/L	6	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	3	100.0%	0.000	0.000	ND	ND
FM-9							
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	1	0.0%			60	60
TPH-Extractables	µg/L	1	0.0%			120	120
Volatile Organic Compounds							
Benzene	µg/L	1	100.0%	0.000	0.000	ND	ND
Ethyl benzene	µg/L	1	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	1	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	1	100.0%	0.000	0.000	ND	ND

Table A-4. Groundwater Monitoring Analytical Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
Toluene	µg/L	1	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	1	100.0%	0.000	0.000	ND	ND
MW-406							
Inorganic Parameters							
Total Dissolved Solids	mg/L	4	0.0%	492.5	490	480	510
Alkalinity-Bicarbonate	mg/L	3	0.0%	260	260	250	270
Alkalinity-Carbonate	mg/L	3	100.0%	0.000	0.000	ND	ND
Alkalinity-Total	mg/L	4	0.0%	260	260	250	270
Alkalinity,hydroxide	mg/L	2	100.0%	0.000	0.000	ND	ND
Bicarbonate (as CaCO3)	mg/L	1	0.0%			260	260
Chloride	mg/L	4	0.0%	74.25	74	71	78
Fluoride	mg/L	1	100.0%			ND	ND
Hardness (as CaCO3)	mg/L	4	0.0%	304.75	304.5	290	320
Methylene Blue Active Substances	mg/L	3	100.0%	0.000	0.000	ND	ND
Nitrate as N	mg/L	2	0.0%	15.75	15.75	6.5	25.0
Nitrate as NO3	mg/L	2	0.0%	27.5	27.5	26	29
PH	s.u.	4	0.0%	7.78	7.65	7.50	8.33
Specific Conductance	µmhos/cm	4	0.0%	830	850	780	870
Sulfate	mg/L	3	0.0%	49	49	49	49
Metals							
Aluminum	mg/L	4	0.0%	2.6	2.6	1.3	3.9
Antimony	mg/L	4	100.0%			ND	ND
Arsenic	mg/L	4	100.0%			ND	ND
Barium	mg/L	4	0.0%	0.168	0.165	0.150	0.190
Beryllium	mg/L	4	75.0%	0.001	0.000	ND	0.002
Cadmium	mg/L	4	100.0%	0.000	0.000	ND	ND
Calcium	mg/L	4	0.0%	71	71.5	66	75
Chromium	mg/L	4	0.0%	0.028	0.030	0.020	0.031
Cobalt	mg/L	4	100.0%	0.000	0.000	ND	ND
Copper	mg/L	4	25.0%	0.011	0.012	ND	0.019
Iron	mg/L	4	0.0%	2.725	2.650	1.3	4.3
Lead	mg/L	4	50.0%	0.003	0.002	ND	0.008
Magnesium	mg/L	3	0.0%	28	28	27	29
Manganese	mg/L	4	0.0%	0.065	0.067	0.035	0.090
Mercury	mg/L	4	75.0%	0.009	0.000	ND	0.037
Molybdenum	mg/L	4	100.0%	0.000	0.000	ND	ND
Nickel	mg/L	4	25.0%	0.012	0.008	ND	0.030
Potassium	mg/L	4	0.0%	3.5	3.35	2.7	4.6
Selenium	mg/L	4	100.0%	0.000	0.000	ND	ND
Silver	mg/L	4	100.0%	0.000	0.000	ND	ND
Sodium	mg/L	4	0.0%	72	72.5	61	82
Thallium	mg/L	4	100.0%	0.000	0.000	ND	ND
Vanadium	mg/L	4	0.0%	0.009	0.009	0.007	0.012
Zinc	mg/L	4	0.0%	0.086	0.031	0.02	0.26
Radiochemical parameters							
TRITIUM	pCi/L	1	0.0%			-118	-118
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	4	25.0%	202.5	115.	ND	580
TPH-Extractables	µg/L	2	0.0%	175	175	0	350
TRICHLOROTRIFLUOROETHANE	µg/L	2	100.0%	0.000	0.000	ND	ND

Table A-4. Groundwater Monitoring Analytical Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	5	100.0%	0.000	0.000	ND	ND
1,1,2,2-Tetrachloroethane	µg/L	5	100.0%	0.000	0.000	ND	ND
1,1,2-Trichloroethane	µg/L	5	100.0%	0.000	0.000	ND	ND
1,1-Dichloroethane	µg/L	5	100.0%	0.000	0.000	ND	ND
1,1-Dichloroethene	µg/L	5	100.0%	0.000	0.000	ND	ND
1,2-Dichlorobenzene	µg/L	5	100.0%	0.000	0.000	ND	ND
1,2-Dichloroethane	µg/L	5	100.0%	0.000	0.000	ND	ND
1,2-Dichloroethene (Total)	µg/L	3	100.0%	0.000	0.000	ND	ND
1,2-Dichloropropane	µg/L	5	100.0%	0.000	0.000	ND	ND
1,3-Dichlorobenzene	µg/L	5	100.0%	0.000	0.000	ND	ND
1,4-Dichlorobenzene	µg/L	5	100.0%	0.000	0.000	ND	ND
2-Chloroethyl vinyl ether	µg/L	2	100.0%	0.000	0.000	ND	ND
Benzene	µg/L	3	100.0%	0.000	0.000	ND	ND
Bromodichloromethane	µg/L	5	100.0%	0.000	0.000	ND	ND
Bromoform	µg/L	5	100.0%	0.000	0.000	ND	ND
Bromomethane	µg/L	5	100.0%	0.000	0.000	ND	ND
Carbon tetrachloride	µg/L	5	100.0%	0.000	0.000	ND	ND
Chlorobenzene	µg/L	5	100.0%	0.000	0.000	ND	ND
Chloroethane	µg/L	5	100.0%	0.000	0.000	ND	ND
Chloroform	µg/L	5	100.0%	0.000	0.000	ND	ND
Chloromethane	µg/L	5	100.0%	0.000	0.000	ND	ND
cis-1,2-Dichloroethene	µg/L	5	100.0%	0.000	0.000	ND	ND
cis-1,3-Dichloropropene	µg/L	5	100.0%	0.000	0.000	ND	ND
Dibromochloromethane	µg/L	5	100.0%	0.000	0.000	ND	ND
Dichlorodifluoromethane	µg/L	5	100.0%	0.000	0.000	ND	ND
Ethyl benzene	µg/L	3	100.0%	0.000	0.000	ND	ND
Freon 113	µg/L	3	100.0%	0.000	0.000	ND	ND
Methylene chloride	µg/L	5	100.0%	0.000	0.000	ND	ND
o-Xylene	µg/L	2	100.0%	0.000	0.000	ND	ND
p,m-Xylenes	µg/L	2	100.0%	0.000	0.000	ND	ND
Tetrachloroethene	µg/L	5	20.0%	1.800	1.900	ND	2.800
Toluene	µg/L	3	100.0%	0.000	0.000	ND	ND
Total Xylenes	µg/L	3	100.0%	0.000	0.000	ND	ND
trans-1,2-Dichloroethene	µg/L	5	100.0%	0.000	0.000	ND	ND
trans-1,3-Dichloropropene	µg/L	5	100.0%	0.000	0.000	ND	ND
Trichloroethene	µg/L	5	100.0%	0.000	0.000	ND	ND
Trichlorofluoromethane	µg/L	5	100.0%	0.000	0.000	ND	ND
Vinyl chloride	µg/L	5	100.0%	0.000	0.000	ND	ND
NLF-6							
Inorganic Parameters							
Alkalinity-Bicarbonate	mg/L	1	0.0%			460	460
Alkalinity-Carbonate	mg/L	1	100.0%			ND	ND
Alkalinity-Total	mg/L	1	0.0%			460	460
Alkalinity,hydroxide	mg/L	1	100.0%			ND	ND
Chloride	mg/L	1	0.0%			353	353
Hardness (as CaCO3)	mg/L	1	0.0%			1200	1200
Methylene Blue Active Substances	mg/L	1	100.0%			ND	ND
Nitrate as NO3	mg/L	1	0.0%			43	43
pH	s.u.	1	0.0%			7.3	7.3
Solids, Total Dissolved	mg/L	1	0.0%			1700	1700

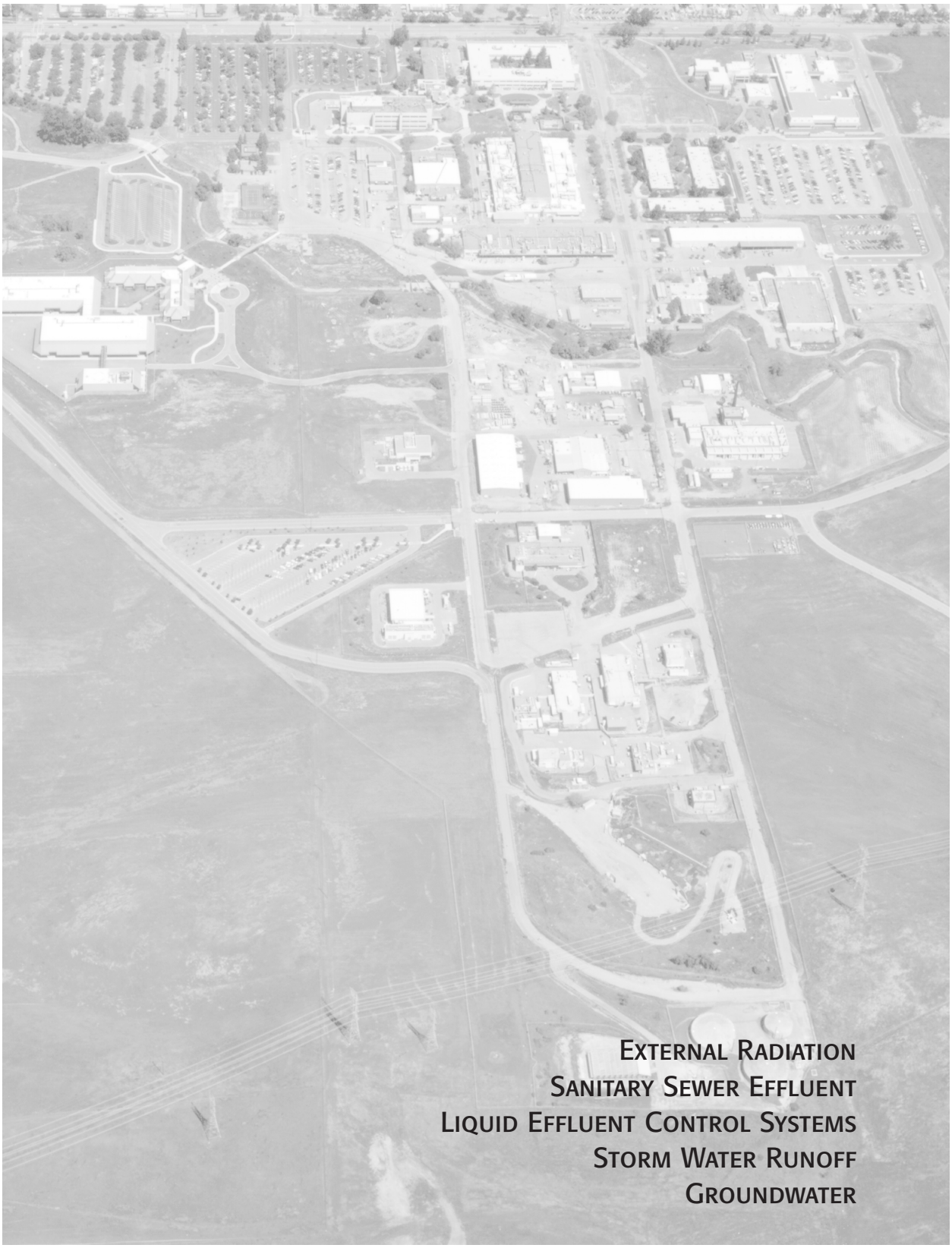
Table A-4. Groundwater Monitoring Analytical Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
Specific Conductance	µmhos/cm	1	0.0%			3200	3200
Sulfate	mg/L	1	0.0%			414	414
Metals							
Aluminum	mg/L	1	100.0%			ND	ND
Antimony	mg/L	1	100.0%			ND	ND
Arsenic	mg/L	1	0.0%			0.009	0.009
Barium	mg/L	1	0.0%			0.089	0.089
Beryllium	mg/L	1	100.0%			ND	ND
Cadmium	mg/L	1	100.0%			ND	ND
Calcium	mg/L	1	0.0%			140	140
Chromium	mg/L	1	0.0%			0.450	0.450
Cobalt	mg/L	1	0.0%			0.005	0.005
Copper	mg/L	1	0.0%			0.140	0.140
Iron	mg/L	1	0.0%			29	29
Lead	mg/L	1	100.0%			ND	ND
Magnesium	mg/L	1	0.0%			180	180
Manganese	mg/L	1	0.0%			0.093	0.093
Mercury	mg/L	1	100.0%			ND	ND
Molybdenum	mg/L	1	100.0%			ND	ND
Nickel	mg/L	1	0.0%			0.5	0.5
Potassium	mg/L	1	0.0%			3.6	3.6
Selenium	mg/L	1	0.0%			0.007	0.007
Silver	mg/L	1	100.0%			ND	ND
Sodium	mg/L	1	0.0%			240	240
Thallium	mg/L	1	100.0%			ND	ND
Vanadium	mg/L	1	0.0%			0.007	0.007
Zinc	mg/L	1	0.0%			0.330	0.330
Radiochemical parameters							
TRITIUM	pCi/L	1	0.0%			34	34
Semi-volatile Organic Compounds							
TPH-Diesel	µg/L	1	100.0%			ND	ND
TRICHLOROTRIFLUOROETHANE	µg/L	1	100.0%			ND	ND
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	4	100.0%	0.000	0.000	ND	ND
1,1,2,2-Tetrachloroethane	µg/L	4	100.0%	0.000	0.000	ND	ND
1,1,2-Trichloroethane	µg/L	4	100.0%	0.000	0.000	ND	ND
1,1-Dichloroethane	µg/L	4	100.0%	0.000	0.000	ND	ND
1,1-Dichloroethene	µg/L	4	100.0%	0.000	0.000	ND	ND
1,2-Dichlorobenzene	µg/L	4	100.0%	0.000	0.000	ND	ND
1,2-Dichloroethane	µg/L	4	100.0%	0.000	0.000	ND	ND
1,2-Dichloroethene (Total)	µg/L	3	100.0%	0.000	0.000	ND	ND
1,2-Dichloropropane	µg/L	4	100.0%	0.000	0.000	ND	ND
1,3-Dichlorobenzene	µg/L	4	100.0%	0.000	0.000	ND	ND
1,4-Dichlorobenzene	µg/L	4	100.0%	0.000	0.000	ND	ND
2-Chloroethyl vinyl ether	µg/L	1	100.0%	0.000	0.000	ND	ND
Bromodichloromethane	µg/L	4	100.0%	0.000	0.000	ND	ND
Bromoform	µg/L	4	100.0%	0.000	0.000	ND	ND
Bromomethane	µg/L	4	100.0%	0.000	0.000	ND	ND
Carbon tetrachloride	µg/L	4	25.0%	0.9	0.95	ND	1.7
Chlorobenzene	µg/L	4	100.0%	0.000	0.000	ND	ND

Table A-4. Groundwater Monitoring Analytical Data. (continued)

Parameter	Unit	Size	% NDs	Mean	Median	Min	Max
Chloroethane	µg/L	4	100.0%	0.000	0.000	ND	ND
Chloroform	µg/L	4	0.0%	0.743	0.700	0.57	1.00
Chloromethane	µg/L	4	100.0%	0.000	0.000	ND	ND
cis-1,2-Dichloroethene	µg/L	4	100.0%	0.000	0.000	ND	ND
cis-1,3-Dichloropropene	µg/L	4	100.0%	0.000	0.000	ND	ND
Dibromochloromethane	µg/L	4	100.0%	0.000	0.000	ND	ND
Dichlorodifluoromethane	µg/L	4	100.0%	0.000	0.000	ND	ND
Freon 113	µg/L	3	100.0%	0.000	0.000	ND	ND
Methylene chloride	µg/L	4	100.0%	0.000	0.000	ND	ND
Tetrachloroethene	µg/L	4	100.0%	0.000	0.000	ND	ND
trans-1,2-Dichloroethene	µg/L	4	100.0%	0.000	0.000	ND	ND
trans-1,3-Dichloropropene	µg/L	4	100.0%	0.000	0.000	ND	ND
Trichloroethene	µg/L	4	100.0%	0.000	0.000	ND	ND
Trichlorofluoromethane	µg/L	4	100.0%	0.000	0.000	ND	ND
Vinyl chloride	µg/L	4	100.0%	0.000	0.000	ND	ND

Appendix B — Laboratory Procedures



External Radiation
Sanitary Sewer Effluent
Liquid Effluent Control Systems
Storm Water Runoff
Groundwater

Chemical and physical analyses on Liquid Effluent Control System (LECS), sanitary sewer, and groundwater samples are done by a state-certified commercial laboratory.

For a commercial laboratory to be considered for use by Sandia National Laboratories (SNL, California), it must be accredited by the State Department of Health Services.

Following is a brief synopsis of the analyses done on samples from each of the environmental media.

EXTERNAL RADIATION

The dosimeters collected by Lawrence Livermore National Laboratory (LLNL) are processed by LLNL's Hazards Control Department, using automated equipment. The dosimeters are received from the Monitoring Group and stored in a lead shield until they are processed.

The dosimeters collected by SNL, California personnel are processed by the Health Instrumentation Department at SNL, New Mexico. These dosimeters are also stored in a lead shield before processing.

SANITARY SEWER EFFLUENT

Tritium

Sewer samples are distilled in preparation for tritium counting. SNL, California's Health Physics organization does the counting by liquid scintillation.

Other Analyses

The metals and organics samples are sent to a State-certified, commercial laboratory, where they are processed in accordance with Environmental Protection Agency (EPA) protocols. The analyses performed on sanitary sewer effluent samples are EPA method 624 (volatile organics), EPA method 625 (semivolatile organics), metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, Zn), chemical oxygen demand, biological oxygen demand, cyanide, total dissolved solids, and total suspended solids.

LIQUID EFFLUENT CONTROL SYSTEMS

Metals

Samples are sent to a state-certified commercial laboratory.

Metals analyses are performed by Inductively Coupled Plasma-Atomic Emission Spectra (ICP-AES) in accordance with internal Environmental Protection Department procedures, which are compatible with applicable EPA procedures.

STORM WATER RUNOFF

Samples are sent to a State-certified, commercial laboratory, where they are processed in accordance with EPA protocols. The analyses performed on storm water runoff samples are: ammonia, cyanide, metals (Al, As, Cd, Cr, Cu, Fe, Hg, Mg, Pb, Ni, Se, Ag, Zn), pH , total suspended solids, specific conductivity, oil and grease, chemical oxygen demand, nitrate/nitrite. SNL, California performed the tritium analyses.

GROUNDWATER

Groundwater samples are analyzed by a State-certified commercial laboratory. The samples are processed in accordance with EPA protocols. The analyses performed on groundwater samples are EPA method 624 (volatile organics), EPA method 625 (semivolatile organics), CCR Title 22 organics, metals (As, Ba, Be, Cd, Cr, Pb, Se, Ag), gross alpha, gross beta, and tritium.

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